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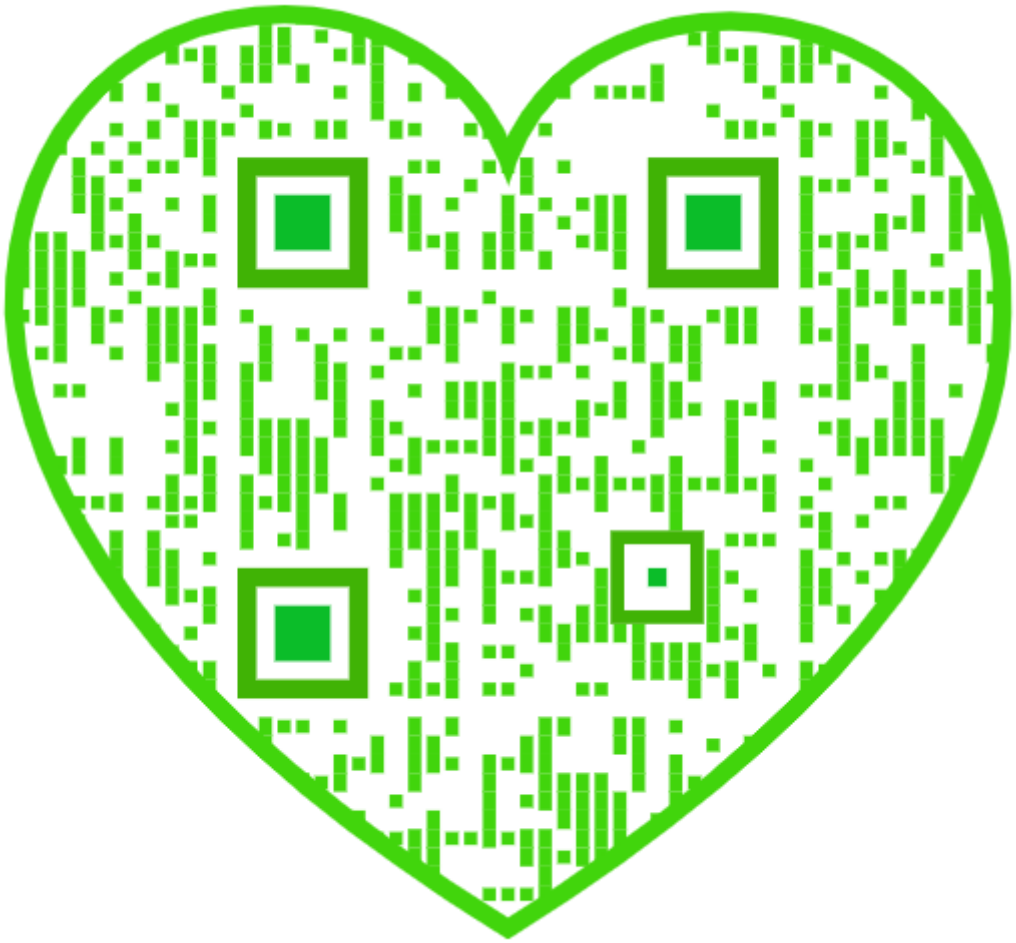

UNITED STATES DEPARTMENT OF AGRICULTURE
Bureau of Agricultural Economics

In Cooperation with

The New York State College of Agriculture, Cornell University
The School of Agriculture, Pennsylvania State College
The Michigan State College of Agriculture and Applied Science
The College of Agriculture, University of Arkansas

PRACTICES FOLLOWED BY GRAPE GROWERS IN FERTILIZING, TILLING, SPRAYING, AND DUSTING, IN NEW YORK, PENNSYLVANIA, MICHIGAN, AND ARKANSAS VINEYARDS

A Preliminary Report

Washington, D. C.
March 1934

Acknowledgments

The Departments of Agricultural Economics in the Colleges of Agriculture in New York, Pennsylvania, Michigan, and Arkansas cooperated in this study with the Bureau of Agricultural Economics of the U. S. Department of Agriculture. The States furnished enumerators to do the field work. The United States Department of Agriculture furnished printed schedules to record the information. The same form was used in each State.

All calculations and tabulations from these records as published in this report were made by the U. S. Department of Agriculture.

It usually required 3 hours or more for the enumerator to fill out the schedule for one farm, and about as much more time for him to copy and check each record. Complete records on both farm business and costs were obtained for 548 farms. On a few of these farms, two cost records were obtained.

A tribute to the patience of both farmers and enumerators is here made. The names of the enumerators and the number of complete records taken by each follow: Pennsylvania: J. T. Vandenburg 41, P. I. Wrigley 36, G. P. Scoville* 25; Total 102. New York: A. B. Lewis 54, Broder F. Lucas 49, G. P. Scoville* 46, Rollin H. Barrett 34, A. Knoblauch 27, D. D. Harkness 18, H. G. Becker 17, H. J. Stover 12, E. P. Dargan 11, Milo F. Winchester 7, L. B. Foreman 2; Total 277. Michigan: F. T. Riddell 15, G. P. Scoville* 13, K. H. Myers** 12, A. Knoblauch 11, J. J. Bird 11, E. A. Orr 10, K. A. Sprague 8, Oscar Steanson** 8, E. B. Hill 3; Total 91. Arkansas: E. P. Dargan 44, G. P. Scoville* 33, Peter Nelson 1; Total 78. The number of records taken is not a measure of the rate of taking records, as the total time the enumerators worked varied from 3 days to 3 months or more.

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*Employed part time by the U. S. Department of Agriculture and part time by Cornell University.

**Employees of the U. S. Department of Agriculture.

PRACTICES FOLLOWED BY GRAPE GROWERS IN FERTILIZING, TILLING, SPRAYING, AND DUSTING IN NEW YORK, PENNSYLVANIA, MICHIGAN, AND ARKANSAS VINEYARDS

By G. P. Scoville, Formerly Agricultural Economist,
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BASIS OF STUDY

This report is the third of a series published by the United States Department of Agriculture on economic phases of eastern grape farming. The main basis for the series is information covering the farm business, and cost of grape production, on 548 farms located in 4 States, as shown under "Acknowledgments." Details concerning location, size, and age of the vineyards studied are given in the first report "Grape Varieties, Yields, Production Costs, and Costs of Maintaining Vines and Trellis, New York, Pennsylvania, Michigan, and Arkansas Vineyards.". The second report presents an analysis of a part of the study under the title "Methods Used by Growers in Marketing Grapes, Grape Prices, Grades, and Consumption per Capita, New York, Pennsylvania, Michigan and Arkansas Vineyards."

In addition to these reports, which present data for all areas studied in the 4 cooperating States, the Pennsylvania State College has published Bulletin 260, "Growing and Marketing Grapes in Erie County, Pennsylvania" and New York State College of Agriculture has published a number of preliminary reports, primarily for New York growers, covering various phases of the study.

COMMERCIAL FERTILIZERS

Purchases

For the year of this study (1928 for all areas except Arkansas which was for 1929), a majority of the growers in each of the areas purchased fertilizers. The proportion of growers buying fertilizer varied from 51.1 percent in Michigan to 90.7 percent in North East, Pa. (table 1.)

For the growers buying fertilizer, an average of 3.91 tons per farm was purchased. The quantity varied from 1.89 tons for the Michigan farms to 10.71 tons per farm for the growers about Girard, Pa. Most of the fertilizer bought by the Michigan growers (83 percent) was used on vineyards whereas in Niagara County, N.Y., the interviewed growers used most of their fertilizer on other crops, only 6 percent being used on vineyards.

About one half the tonnage and one half the value of all fertilizer bought by the interviewed grape growers, in all of the areas, represented ready-mixed goods. The proportion was highest in Pennsylvania where 60 percent of the fertilizer expense was for mixed goods, and lowest in Michigan, where mixed goods represented only 20 percent of the total expense for fertilizers. On the farms studied in Arkansas and in the Finger Lakes area of New York, more was spent for sodium nitrate than for mixed fertilizers. For all farms studied in all areas about one half as much was spent for sodium nitrate as for mixed goods.

In Michigan 71 percent of the expenditure for fertilizer was for ammonium sulphate. Girard growers also used considerable quantities of ammonium sulphate. The average price paid in 1928 was $59.29 per ton which was practically the same as the price paid for sodium nitrate. Since sodium nitrate carries about 19 percent ammonia, and ammonium sulphate 24.3 percent ammonia, 20 pounds of ammonia were purchased in sodium nitrate for $3.09 and in ammonium sulphate for $2.44.

For every dollar spent for fertilizer by the grape growers in all the areas studied, 51 cents were spent for mixed fertilizers, 38 cents for straight nitrogenous fertilizers, and 11 cents for all other kinds.

For all the farms studied, about as many tons of sodium nitrate as of acid phosphate were bought. At the prices paid by these growers in 1928, 20 pounds of phosphoric acid cost on the average $1.33. Only four farmers bought muriate of potash. At $46.25 per ton, 20 pounds of potash cost $0.92.

Ready-mixed fertilizers are sold by analysis. The first number of the analysis refers to the percentage of nitrogen or ammonia carried in the fertilizer, the second number to the percentage of available phosphoric acid, and the last number to the percentage of potash. The sum of the percentage figures of a given analysis represents the units of plant food in the fertilizer. Thus, a 5-8-8 fertilizer contains 5 + 8 + 8, or, 21 units of plant food. In 1928, nitrogen was given in terms of ammonia in the States where this study was made. State regulations as of January 1, 1932 for all but six southern States require that the analysis express nitrogen as nitrogen rather than ammonia.

Table 1. - Kind, quantity and price of commercial fertilizer purchased, by areas, 1928

Kind of fertilizer and area	Percentage of farmers buying fertilizer	Quantity per farm buying	Price per ton	Proportion of total fertilizer bought		Percentage of total tonnage used on grapes
				Tonnage	Value	
	Percent	Tons	Dollars	Percent	Percent	Percent
All kinds:						
North East, Pa.	90.7	7.39	44.96	100	100	64.4
Niagara Co., N.Y.	90.0	3.28	31.51	100	100	6.1
Girard, Pa.	88.5	10.71	37.28	100	100	46.8
Finger Lakes, N.Y.	81.8	2.02	36.92	100	100	27.8
Chautauqua Co., N.Y.	78.6	3.41	38.37	100	100	50.9
Hudson Valley, N.Y.	80.0	4.04	45.29	100	100	45.7
Arkansas (1929)	56.4	2.39	45.60	100	100	20.4
Michigan	51.1	1.89	57.22	100	100	82.6
Average	74.1	3.91	41.85	100	100	49.6
All areas:						
Ready mixed	47.5	3.26	40.21	53.3	51.1	46.9
Sodium nitrate	26.8	2.02	58.74	18.6	26.2	59.5
Acid phosphate	21.5	2.42	21.24	18.0	9.1	37.8
Ammonium sulphate	10.8	1.96	59.29	7.3	10.3	74.7
Bone meal	1.5	2.24	46.91	1.1	1.3	92.8
Tankage	0.5	3.50	39.05	0.7	0.6	46.9
Calcium nitrate	0.4	2.75	66.55	0.3	0.6	90.9
Cyanide	0.4	3.50	48.00	0.4	0.5	14.3
Potash, muriate	0.7	1.00	46.25	0.3	0.3	68.8
Ready mixed:						
North East, Pa.	78.7	5.38	42.07	64.1	60.0	69.6
Niagara Co., N.Y.	75.0	2.35	37.50	59.6	70.9	0.0
Girard, Pa.	69.2	8.02	38.03	58.6	59.7	37.0
Chautauqua Co., N.Y.	61.6	2.47	38.44	56.7	56.8	43.4
Finger Lakes, N.Y.	41.8	1.51	35.87	38.2	37.1	8.7
Hudson Valley, N.Y.	40.0	3.96	42.77	50.7	46.4	45.9
Arkansas (1929)	33.3	1.37	41.01	33.8	30.4	3.7
Michigan	14.1	1.45	53.58	21.2	19.9	70.4
Sodium nitrate:						
North East, Pa.	45.3	3.35	59.71	23.0	30.5	59.9
Finger Lakes, N.Y.	40.9	1.03	59.64	25.6	41.3	85.6
Hudson Valley, N.Y.	34.3	2.90	56.12	30.8	38.1	29.6
Chautauqua Co., N.Y.	33.9	1.50	59.60	19.0	29.5	69.7
Arkansas (1929)	16.7	3.13	55.08	38.6	46.6	38.9
Ammonium sulphate:						
Girard, Pa.	46.2	3.01	58.57	14.7	23.0	65.1
Michigan	40.2	1.62	60.11	67.8	71.2	90.3
Acid phosphate:						
Girard, Pa.	46.2	5.24	22.52	25.5	15.4	56.5
Niagara Co., N.Y.	40.0	2.79	19.87	37.7	23.8	9.0
Finger Lakes, N.Y.	32.7	1.73	19.91	34.3	18.5	2.6
Chautauqua Co., N.Y.	28.6	2.28	21.58	24.3	13.7	54.1
North East, Pa.	21.3	2.61	20.97	8.4	3.9	59.1
Hudson Valley, N.Y.	14.3	1.30	18.92	5.8	2.4	46.2
Arkansas (1929)	9.0	2.02	22.47	13.4	6.6	8.5

Only the Pennsylvania farmers reported the use of a 5-8-8 fertilizer, and in this State 43 of the 97 farmers interviewed reported its purchase, Sixty-three percent of this fertilizer was used on grapes, A 2-8-10 fertilizer was bought by 31 growers in six of the areas studied. Only 4 percent of the 2-8-10 fertilizer was applied to grapes. Most of the mixed fertilizers used on grapes carried from 5 to 7 percent ammonia.

The costs of the units of plant food in each of several ready-mixed fertilizers compared with the costs of the same units of plant food when bought unmixed as sodium nitrate, ammonium sulphate, acid phosphate, and muriate of potash. (table 2.) The source of ammonia in mixed fertilizers is primarily sulphate of ammonia although some nitrate of soda and organic carriers are also used. Organic ammonia in animal and vegetable by-products costs more than inorganic ammonia. In computing the cost of plant food when purchased as unmixed fertilizers, one half of the ammonia was valued at what it would cost in the more expensive nitrate form and one half in the cheaper sulphate form.

Table 2. - Guaranteed analysis of the more important mixed fertilizers and a comparison of the cost of mixed fertilizers and the equivalent plant food in unmixed fertilizers, all areas, 1928

Guaranteed analysis 1/	Farms using	Quantity per farm buying	Percentage of tonnage used on grapes	Price per ton of mixed goods	Cost of same amount of plant food in unmixed goods 2/	Difference in cost of same plant food in mixed and unmixed fertilizers
	Number	Tons	Percent	Dollars	Dollars	Dollars
4-16-4	12	1.59	0	41.20	36.00	5.20
4-8-10	7	1.71	18	38.17	30.88	7.29
5-8-8	43	4.93	63	42.85	31.80	11.05
4-12-4	17	3.12	35	36.77	30.68	6.09
7-8-5	17	4.49	90	43.46	34.56	8.90
2-8-10	31	1.59	4	35.98	25.36	10.62
4-8-7	9	3.49	5	35.94	28.12	7.82
7-6-5	24	3.42	87	42.99	31.90	11.09
5-8-5	6	4.06	75	42.18	29.04	13.14
2-12-2	6	1.96	0	28.75	23.32	5.43
4-8-4	22	1.76	6	34.88	25.36	9.52
2-8-5	5	1.41	65	35.22	20.76	14.46
2-8-4	8	2.18	0	32.76	19.84	12.92

1/ The numbers in the fertilizer analysis refer to percents. The first number stands for ammonia, the second number for available phosphoric acid, and the third for potash.

2/ At prices given in table 1, 20 pounds of ammonia would cost $2.76, if one half of the ammonia was obtained from sodium nitrate and one half from ammonium sulphate. In the form of acid phosphate 20 pounds of available phosphoric acid would cost $1.33 and in the form of muriate of potash 20 pounds of potash, 92 cents.

The fertilizer with the least difference between the mixed and unmixed values was a 4-16-4, carrying 24 units of plant food. The fertilizer with the greatest difference between mixed and unmixed values was a 2-8-5, carrying 15 units of plant food. Fertilizers of high analyses usually furnish a unit of plant food cheaper than do fertilizers of low analyses. For fertilizers having 19 or more units of plant food the difference in price between mixed and unmixed goods was $8.14 compared with $11.09 for fertilizers having 18 or less units of plant food. The additional plant food in a fertilizer of high analysis is usually bought by a farmer at wholesale prices. 1/

Fertilizers are sometimes applied to such low-valued crops or to such poorly drained soils that there can be little or no increase in returns from their use. Under such conditions it is best to apply no fertilizer, or if fertilizer is applied, the lower the grade and the lower the cost the less the loss.

Application to Vineyards

In 1928, about 4 out of 5 Pennsylvania growers fertilized their vineyards. Of the areas studied in New York the most fertilizer was used on the vineyards in the Hudson Valley. In this area, about 2 growers out of 3 fertilized their vineyards. Nearly half the growers interviewed in Chautauqua Co., N.Y. applied fertilizer to their vineyards, but only 34.5 percent of the acreage was fertilized. In the Finger Lakes area, 2 farmers out of 5 applied fertilizer to their vineyards, and about 30 percent of the total grape acreage studied in this area was fertilized in 1928.

In Michigan, fertilizer was applied to 45 percent of the vineyards and covered about 39 percent of the total grape acreage studied in that State.

In Arkansas, in 1929, 14 vineyards out of 78, or about 1 out of 6 were fertilized. These 14 vineyards contained 313 acres that were fertilized and 1 of these vineyards contained 165 acres, or about 53 percent of the total fertilized acreage.

For the farms studied in all areas, about one third of the total vineyard acreage that was fertilized was treated with ready-mixed fertilizers and one third with sodium nitrate, either alone or in combination with acid phosphate. (table 3.) A majority of the vineyard acreage fertilized in North East, Pa., and in the Hudson Valley, was treated with ready-mixed fertilizers. Sodium nitrate was used on about 86 percent of the acreage fertilized in the Finger Lakes area and sodium nitrate either alone or in combination with acid phosphate was used on 47 percent of the acreage fertilized in Chautauqua Co., N.Y. In Michigan, 4 acres out of 5 acres of vineyard that were fertilized were fertilized with ammonium sulphate.

1/ Vial, E. E. Relation of the Retail Price and Guaranteed Analysis of Mixed Fertilizers sold in New York, 1923-1927. Published in "Farm Economics," No. 54, September 1928. New York State College of Agriculture, Cornell University, Ithaca, N. Y.

Table 3. - Commercial fertilizers used on vineyards studied, by areas, 1928

Kind of fertilizer and area	Growers applying fertilizer	Percentage of - Acreage studied that was fertilized	Percentage of - Fertilized acreage receiving indicated fertilizers	Fertilizer per acre	Cash cost of fertilizer per acre fertilized
	Number	Percent	Percent	Pounds	Dollars
All kinds:					
Girard, Pa.	21	88.6	100.0	657	13.04
North East, Pa.	61	76.7	100.0	422	9.47
Michigan	41	38.6	100.0	153	4.43
Hudson Valley, N.Y.	24	63.2	100.0	455	9.86
Finger Lakes, N.Y.	46	29.9	100.0	194	5.51
Arkansas (1929)	14	29.5	100.0	137	3.46
Chautauqua Co., N.Y.	54	34.5	100.0	368	7.54
Niagara Co., N.Y.	3	7.4	100.0	503	9.30
Total or average	264	44.7	100.0	334	7.58
All areas:					
Ready mixed	93	15.0	33.8	458	9.81
Sodium nitrate, alone	81	11.5	25.6	204	6.00
Ammonium sulphate, alone	42	8.3	18.5	147	4.37
$NaNO_3$ & P_2O_5 combined	23	4.1	9.1	475	8.68
Acid phosphate, alone	16	1.4	3.2	352	4.09
All other	28	4.4	9.8	460	10.16
Ready-mixed:					
North East, Pa.	36	42.4	55.3	471	10.06
Girard, Pa.	10	36.1	40.8	718	15.40
Hudson Valley, N.Y.	14	32.9	52.1	475	10.10
Chautauqua Co., N.Y.	24	13.5	39.0	422	8.58
Michigan	5	5.0	13.0	196	5.47
Finger Lakes, N.Y.	3	1.5	5.2	448	10.04
Arkansas (1929)	1	1.6	5.4	153	2.94
Sodium nitrate:					
Finger Lakes, N.Y.	40	25.7	85.8	173	5.20
Arkansas (1929)	6	18.3	61.9	120	3.05
North East, Pa.	15	16.5	31.6	254	7.59
Hudson Valley, N.Y.	6	15.3	24.1	367	9.96
Chautauqua Co., N.Y.	12	7.7	22.4	225	6.85
Niagara Co., N.Y.	2	3.6	48.9	314	10.14
Ammonium sulphate:					
Michigan	33	31.0	80.3	140	4.18
Girard, Pa.	4	5.3	6.0	298	8.76
Arkansas (1929)	2	2.2	7.7	100	2.75
North East, Pa.	2	2.0	2.6	225	6.45
Finger Lakes, N.Y.	1	1.6	5.2	148	4.59
Sodium nitrate and acid phosphate:					
Chautauqua Co., N.Y.	12	8.4	24.4	440	7.79
North East, Pa.	8	10.7	13.9	501	9.39
Acid phosphate:					
Girard, Pa.	2	11.0	12.4	506	5.61
Niagara Co., N.Y.	1	2.5	33.6	550	4.58
Hudson Valley, N.Y.	2	2.8	4.4	400	3.70
Chautauqua Co., N.Y.	7	3.4	9.7	263	3.41
Arkansas (1929)	3	0.8	2.7	286	3.33
Michigan	1	0.2	0.4	250	3.50

For the vineyards fertilized in all the areas, an average of 334 pounds of fertilizer were applied per acre, which cost the growers $7.58. The Girard vineyards that were fertilized with mixed fertilizers had on the average the heaviest application, 718 pounds per acre, which cost $15.40. On the average, vineyards at North East, Pa., that were fertilized, received about two thirds as much fertilizer per acre as the Girard vineyards. The fertilizer applications for Hudson Valley as given in table 3 include only about three fourths of the total application per acre of land; since for those vineyards that were interplanted, only a part of the total fertilizer application was charged to grapes. The total fertilizer applications in the Hudson Valley were slightly heavier than in the North East area.

The average application of sodium nitrate on the Finger Lakes vineyards was 173 pounds per acre, which cost $5.20. In Chautauqua County, on the average, 225 pounds of sodium nitrate were applied per acre. In Chautauqua County when both sodium nitrate and acid phosphate were applied, the average rate of sodium nitrate was 156 pounds and of acid phosphate 284 pounds. In Michigan, ammonium sulphate was applied at the average rate of 140 pounds per acre, which cost $4.18. Michigan and Arkansas were the only areas where the fertilizer applied cost on the average less than $5.00 per acre.

Dates and Cost of Applying

The Hudson Valley growers in 1928 fertilized 6 acres of grapes in April to each 4 acres fertilized in May. Of the acreage fertilized in Michigan, about one half (46.8 percent) was treated before May, and 11 percent after May. (table 4.) Some growers delayed applying fertilizer until the vineyard was plowed and harrowed. In the Chautauqua-Erie area about half the acreage was fertilized in the first 2 weeks in May. On the lighter textured soils in the Chautauqua-Erie area, one third of the acreage was fertilized in April whereas on the heavier textured soils about one fourth of the acreage was fertilized in June and July. Fertilizers were generally applied later in the season in the Finger Lakes area than in the Chautauqua-Erie area. Of the acreage fertilized in the Finger Lakes area, 4 acres out of each 10 acres were fertilized in June.

To get the best results from nitrogenous fertilizers, Dr. Partridge states 2/ that the application should be made early in the season, at the time when the buds are bursting, if the full effect on growth is to be obtained.

On the average, 1.3 hours of man labor per acre were used to apply fertilizer. (table 5.) For 24 farms in the Hudson Valley, the average amount of man labor was 4.1 hours per acre. For the other areas, the man labor varied from an average of 1.0 hour for the vineyards in Michigan and at North East, Pa., to 1.9 hours for the vineyards in Niagara Co., N.Y. The average cost of man labor and power used in fertilizing vineyards was $1.04 per acre.

2/ Partridge, N. L. Cultural Methods in the Bearing Vineyard Michigan Agricultural Experiment Station, Circular Bulletin No. 130, 1930. p. 8.

Table 4. - Distribution of acreage of vineyard fertilized for indicated areas by month and week applied, 1928

Month	Week	Percentage of acreage fertilized: Michigan	Hudson Valley, N.Y.	Chautauqua-Erie 1/: Light texture soils	Chautauqua-Erie 1/: Heavy texture soils	Finger Lakes, N.Y.
		Percent	Percent	Percent	Percent	Percent
March	4th	9.4				
April	1st	3.2	10.4	7.4		
	2nd	17.8	22.6		6.6	1.0
	3rd	1.7	3.9	11.0		
	4th	14.7	23.0	14.2	5.6	
May	1st	25.8	21.1	33.7	17.6	
	2nd	14.4	14.7	20.9	31.2	18.5
	3rd	-	4.3	1.6	7.2	31.5
	4th	2.1		4.3	9.0	8.5
June	1st	5.2		3.4	12.5	13.5
	2nd	1.9		3.5	4.5	17.0
	3rd	0.0			1.1	5.5
	4th	2.9			2.2	4.5
July	1st				2.5	
	2nd	0.9				
Total	-	100.0	100.0	100.0	100.0	100.0

1/ Vineyards in Chautauqua Co., N.Y., and Erie Co., Pa., combined.

Table 5. - Average cost of labor and power per acre for applying commercial fertilizer, by areas, 1928

Area	Vineyards	Quantity of fertilizer per acre	Labor and horse work per acre for applying fertilizer: Man labor	Horse work	Cost per hour: Man labor	Horse work	Cost of man labor and horse work per acre: Applying fertilizer	Hauling to farm and mixing
	Number	Pounds	Hours	Hours	Cents	Cents	Dolls.	Dolls.
Arkansas (1929)	14	137	1.5	0.8	24.2	14.3	0.48	0.07
Michigan	41	153	1.0	1.5	43.7	18.3	.71	.07
Finger Lakes, N.Y.	46	194	1.4	.8	50.1	20.4	.86	.15
North East, Pa.	61	422	1.0	1.4	49.4	26.9	.87	.09
Girard, Pa.	21	657	1.3	1.2	48.5	22.0	.89	.09
Chautauqua Co., N.Y.	54	368	1.5	2.0	47.3	20.9	1/1.15	.27
Niagara Co., N.Y.	3	503	1.9	2.8	43.3	33.8	1.77	.28
Hudson Valley, N.Y. 2/	24	599	4.1	1.8	48.1	26.2	2.44	.31
All areas	264	341	1.3	1.4	46.1	22.5	.91	.13

1/ Includes some cost for use of truck and tractor.

2/ For the Hudson Valley area about three fourths of the amount and cost of labor and power shown in this table is charged to grapes; about one fourth is not charged to grapes because of interplanted fruit and crops.

A crew of 1 man and 2 horses was used to apply fertilizer by 3 growers out of every 10. This was the most efficient crew. (table 6.)

Some growers broadcast fertilizer while harrowing, holding the reins across the shoulders. If the vineyard was to be harrowed after the fertilizer was applied, one trip over the vineyard was thus saved.

Table 6. -Average cost per acre of applying commercial fertilizer with indicated crews, for all vineyards for which data were reported, 1928 1/

Crew	Vineyards	Quantity of fertilizer per acre	Labor and horse work per acre for applying fertilizer: Man labor	Horse work	Cost per hour: Man labor	Horse work	Cost of man labor and horse work per acre: Applying fertilizer	Hauling to farm and mixing
	Number	Pounds	Hours	Hours	Cents	Cents	Dollars	Dollars
By hand	48	243	1.8	-	52.3	-	0.94	0.20
1 man - 1 horse	66	433	1.2	1.2	52.1	30.7	.99	.11
1 man - 2 horses	80	331	1.0	2.0	44.8	18.9	.83	.12
2 men - 1 horse	6	706	2.0	1.0	48.0	23.6	1.20	.14
2 men - 2 horses	45	319	1.4	1.4	47.6	22.3	.98	.14
All other crews	19	269	2.2	1.3	34.5	27.5	2/1.15	.12
All crews	264	341	1.3	1.4	46.1	22.5	.91	.13

1/ Arkansas, 1929.
2/ Includes some cost for use of tractor.

Frequency of Application

For all growers interviewed who reported fertilizer practices for their vineyards for 5 years, 1924-1928, 3 out of 10 used no commercial fertilizer on their vineyards during the 5 years and about 3 out of 10 applied fertilizer during each of the years. (Table 7.) In North East, Pa., three fourths of the growers who applied fertilizer during the 5-year period, applied fertilizer in each of the years. In Arkansas, where fertilizers are not usually applied to vineyards, only one fifth of the growers using fertilizer during the 5 years, applied it every year.

Table 7. - Vineyards fertilized during 5-year period, 1924-1928, by areas

Area	Vineyards fertilized							Percentage of vineyards fertilized	
	0 yr. in 5	1 yr. in 5	2 yrs. in 5	3 yrs. in 5	4 yrs. in 5	5 yrs. in 5	Total vineyards	Annually, 1924-1928 1/	1928
	Number	Number	Number	Number	Number	Number	Number	Percent	Percent
North East, Pa.	2	1	2	1	7	33	46	85.9	81.3
Girard, Pa.	0	1	0	0		7	8	85.3	80.8
Hudson Valley, N.Y.	7	4	2	1	1	17	32	62.3	68.6
Chautauqua Co., N.Y.	25	9	9	15	11	31	100	54.3	48.2
Michigan	17	9	10	8	5	15	64	46.3	44.6
Finger Lakes, N.Y.	31	19	9	11	10	12	92	37.6	40.7
Niagara Co., N.Y.	7	6	1	2	1	0	17	22.6	15.0
Arkansas (1925-1929)	33	12	1	1	2	4	53	15.5	17.9
Total or average	122	61	34	39	37	119	412	48.4	47.9

1/ The sum of the years vineyards were treated with fertilizer was divided by the sum of the years vineyards were studied and the quotient was multiplied by 100. Besides the 412 vineyards reporting whether fertilizer was used for 5 years, there were included 142 other vineyards for which this information was reported from 1 to 4 years.

Relation of Use to Yields, Chautauqua-Erie Vineyards

Vineyards in the Chautauqua-Erie belt on the lighter textured soils were fertilized more than those on the heavier soils. (table 8.) Fertilizer was not applied in 1927 or in 1928 to 7 vineyards studied on the light textured soils or to 29 vineyards on the heavy soils. The proportion of vineyards fertilized was 87 percent on the light soils compared with 55 percent on the heavy soils.

The average application of nitrogen per acre of vineyard fertilized was 21 pounds for the heavy soils and 28 pounds for the light soils. Nitrogen was applied to each vineyard that was fertilized.

On the heavier soils phosphorous was applied to 78 percent, and on the lighter soils, to 85 percent of the vineyards fertilized. When phosphorous was included in the fertilizer, the average quantities of phosphoric acid applied per acre of vineyard were 31 pounds on the heavy soils and 37 pounds on the light soils.

Table 8. - Average grape yields in 1928 for Chautauqua-Erie vineyards that received specified applications of plant food, in both 1927 and 1928

Soil type	Plant food applied per acre: Range	Nitrogen	Phosphoric acid	Potash	Concord grapes: Yield per acre	Acreage per farm	Return per hour of labor	Vineyards
	Pounds	Pounds	Pounds	Pounds	Tons	Acres	Cents	Number
Light-textured soils (gravelly, sandy loam)	Less than 45	10	3	1	1.86	22	14	15
	45 - 90	28	25	14	2.37	25	16	23
	Over 90	30	52	34	2.65	29	18	15
Average	-	25	28	17	2.33	26	16	53
Heavy-textured soils (loam, silt, clay)	0	0	0	0	1.48	21	2	29
	8 - 59	20	6	4	1.65	31	6	18
	Over 59	23	51	11	1.75	16	-6	18
Average	-	12	13	4	1.60	22	1	65

On the heavier soils, potash was applied to 50 percent and on the lighter soils, to 70 percent of the vineyards fertilized. When potash was applied, an average of 15 pounds per acre on the heavy soils, and 27 pounds per acre on the light soils was used.

More of the vineyards on the lighter textured soils were fertilized than on the heavy textured soils because fertilizers have given greater increases in yield on the light textured soils. Lack of drainage limited the production of many vineyards on the heavy textured soils. Not much increase in yield from the use of fertilizers can be expected on poorly drained soils.

On the light-textured soils, vineyards fertilized the heaviest, produced on the average 42 percent more grapes per acre than did vineyards not fertilized or fertilized very little. On the heavy soils the vineyards fertilized the most produced only 18 percent more grapes per acre than did those not fertilized.

Even at the low prices for grapes in 1928, the return per hour of labor from vineyards on the lighter soils that were fertilized the heaviest, averaged 18 cents per hour which was 4 cents more per hour than the average returns from vineyards not fertilized. Fertilizers on the lighter textured soils apparently paid, on the average, in 1928.

Vineyards on the heavy soils that received the most fertilizer returned nothing for the labor spent on the vineyards and lacked 6 cents per hour of paying other costs. On the heavier soils not fertilized the return per hour of labor was 2 cents. (table 8.) On the average, the vineyards on the heavy soils were much less productive than those on the light soils, and the increased yield from the use of fertilizers apparently did not pay for the added expense in 1928.

Included in the heavy soil group were 24 hill vineyards and although fertilizers have been profitably used on hill vineyards situated on deep, well-drained soils such as the Wooster series, much of the hill land in this area has a hard pan layer close to the plow line and is not a profitable soil for vineyards. There were 52 lake plain vineyards in Chautauqua Co., N.Y. that were included in table 8. According to the location of these vineyards on the soil map, 3/ 35 were on heavy soils, (clay, silt, or loam) the predominating type being a silty clay loam. Since this soil is situated next to Lake Erie, low vineyard yields cannot be attributed to lack of water protection. That fertilizer applied to vineyards on heavy soils, did not pay on the average in 1928 is also shown if the Chautauqua County vineyards are averaged separately from the Pennsylvania vineyards. The returns from Chautauqua County vineyards on the heavy lake plain soils when not fertilized averaged 6 cents per hour, which was 19 cents more than the average return from vineyards that were fertilized the heaviest.

The correlation study of these data indicates that when the effects of phosphoric acid and potash remain unchanged, 30 pounds of nitrogen per acre increased the yield of grapes on the light-textured soils 812 pounds per acre compared with 307 pounds on the heavy soils. (table 9.) Although the coefficients of correlation obtained in this study are generally rather low, indicating a strong probability that somewhat different results would be obtained if the study were repeated, certain of them do indicate rather definite tendencies in results to be expected from the use of different kinds of plant foods on the two different types of soil.

The nitrogen for the increased production cost at the average rate of $12.36 per ton of grapes on the light-textured soils and $32.70 on the heavy-textured soils. This does not include the cost of applying the nitrogen. The cost was calculated as if one half the nitrogen was purchased as sodium nitrate and one half as ammonium sulphate. The price paid for nitrogen by these growers was usually more than this because most of the nitrogen used on these vineyards was bought in mixed fertilizers.

Since grapes in these vineyards were usually picked by the basket, the cost of harvesting and marketing per ton averaged about the same for the high-and low-yielding vineyards. In Chautauqua County, N.Y. in 1928, the cost of harvesting and marketing grapes averaged $13 per ton. These growers received an average of $35 per ton, or $22 above the cost of harvesting and marketing. These prices were for 2,000 pounds of grapes and did not include the weight of value of the baskets.

If the extra yield was obtained on the lighter soils at a cost for nitrogen of $12 per ton of grapes, and grapes on the vines were worth $22 per ton, there was $10 left after paying for the nitrogen. On the heavier soils, however, the nitrogen cost of $33 per ton of grapes exceeded the value of grapes by $11.

In reviewing this discussion, F. E. Gladwin, Pomologist, points out that in some of the State Agricultural Experiment Station tests at the vineyard laboratory, Fredonia, N.Y., a vineyard on a heavy soil (silt for a few inches underlain with stiff blue and yellow clays) has responded well to the use of nitrogen.

3/ Morrison, T. M. Engle, C. C., and Fuller, G. L. Soil Survey of Chautauqua County, New York, Cornell Extension Bulletin 6, 1916.

Table 9. - Net effect on 1928 grape yields, of each kind of plant food applied to light- and heavy-textured soils, Chautauqua-Erie vineyards fertilized approximately the same in 1927 and 1928 1/

Soil type	Plant food			Additional grape yield per acre, 1928 2/	Fertilizer cost for additional ton of grapes
	Kind	Quantity per acre	Cost per acre		
		Pounds	Dollars	Pounds	Dollars
Light-textured soils (gravelly, or sandy loams)	Nitrogen	30	5.02	812	12.36
	Phosphoric acid	30	2.00	555	7.21
	Potash	30	1.38	182	15.16
Heavy-textured soils (loam, clay, silt)	Nitrogen	30	5.02	307	32.70
	Phosphoric acid	30	2.00	162	24.69
	Potash	30	1.38	203	13.60

1/ The average coefficients and regression equations derived from the correlation study of fertilizer applications and grape yields on Chautauqua-Erie vineyards are here given for reference.

2/ Increased grape yields calculated from the straight-line regression equations as given below.

Variables	53 vineyards, light soils				65 vineyards, heavy soils			
	Average per acre	Standard deviation	Correlation coefficients		Average per acre	Standard deviation	Correlation coefficients	
			Gross	Partial			Gross	Partial
	Pounds	Pounds	r	r	Pounds	Pounds	r	r
Plant food per acre								
Nitrogen	24.6	16.6	+.43	+.37	12.3	14.8	+.25	+.11
Phosphoric acid	28.3	24.4	+.47	+.30	16.9	27.5	+.26	+.10
Potash	16.5	17.9	+.35	+.08	7.7	18.3	+.23	+.09
Dependent variable								
Grape yields	4720	1340			3420	1160		
Multiple correlation				+.57				+.30

Regression equation, X_1 = Grape yield in tons; Pounds of plant food applied per acre, Nitrogen X_2; Phosphoric acid X_3; Potash X_4; Light-textured soils $X_1 = 1.714 + .01354\ X_2 + .00925\ X_3 + .00303\ X_4$. Heavy-textured soils $X_1 = 1.578 + .00511\ X_2 + .00270\ X_3 + .00339\ X_4$.

In the opinion of the author, if soils are equally well drained, fertilizers may give as great an increase in yield on heavy- as on light-textured soils. But because of poor drainage there are many vineyards on heavy soils on which fertilizers cannot be used at a profit under present price conditions.

The application of 30 pounds of phosphoric acid per acre, nitrogen and potash remaining the same, on the average, increased the yield per acre by 555 pounds of grapes on the light-textured soils and by 162 pounds on the heavy soils. Although the increased yield from 30 pounds of phosphoric acid was not so great as from 30 pounds of nitrogen, the gain from phosphoric acid was more economical because 30 pounds of phosphoric acid cost only 40 percent as much as 30 pounds of nitrogen. The phosphoric acid cost for the increased yield on the light-textured soils was $7.21 per ton of grapes and $24.69 on the heavy-textured soils.

The gain per 30 pounds of potash, when nitrogen and phosphoric acid remain the same, was 182 pounds of grapes per acre on the light-textured soils and 303 pounds on the heavy soils. The potash cost for the increased yield was $15.16 on the light-textured soils and $13.60 on the heavy soils.

Results from fertilizer tests conducted at the Fredonia, N.Y., vineyard laboratory since 1909 are listed in table 10. The vineyard at the laboratory is on a gravelly loam soil, which is one of the light-textured soils in the Chautauqua-Erie grape belt.

For 9 years plats 2 and 8 received application at the rate per acre of 100 pounds of sodium nitrate, 400 pounds of dried blood, 300 pounds of acid phosphate, and 200 pounds of sulphate of potash. This was equivalent to 47 pounds of nitrogen, 42 pounds of phosphoric acid, and 96 pounds of potash per acre. For the last 15 years only 40 pounds of nitrogen were used per acre, all carried in nitrate of soda. The earlier quantities of acid phosphate and sulphate of potash were continued throughout the 24 years. These plats averaged 1.32 tons more grapes per acre than did plat No. 6 where no fertilizer was applied.

None of the vineyards studied in Chautauqua County and only 2 vineyards in Pennsylvania that used approximately the same fertilizer in 1927 as in 1928, received as much as 185 pounds of plant food per acre, the average quantity used in the fertilizer tests on plats 2 and 8. However, the results of the correlation study show that this quantity of plant food when applied to the light-textured soils increased the yield 1.32 tons which corresponds with the total increase obtained at the vineyard laboratory, Fredonia, N.Y.

Of the vineyards that were fertilized approximately the same in 1927 as in 1928, 4 Pennsylvania vineyards and 1 Chautauqua County vineyard received as much as 47 pounds of nitrogen in commercial fertilizer. The experiences of Chautauqua-Erie growers with vineyards on light-textured soils compared with the results of the Fredonia fertilizer tests indicate increases in yield, from the use of 47 pounds of nitrogen, of 1273 and 1627 pounds of grapes respectively. (table 11.)

Table 10. - Grape yields obtained in commercial fertilizer tests conducted at Fredonia laboratory, Chautauqua Co., N.Y., 1909-1930, Fertilizer treatment for each plot with yields converted to acre basis 1/

Year	N.P. K.L. (1)	N.P. K. (2)	N.P. (3)	N.K. (4)	P.K. (5)	Check (6)	N.P. K.L. (7)	N.P.K. (8)	N.P. (9)	N.K. (10)	P.K. (11)
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
1909	4.48	4.76	5.17	4.25	3.41	3.38	4.69	4.66	4.99	4.79	4.99
1910	2.10	2.21	2.14	2.55	2.00	2.10	2.38	2.07	2.04	2.26	1.87
1911	5.37	5.71	5.61	5.64	5.44	5.32	5.62	5.71	5.35	5.91	5.03
1912	3.46	4.30	4.00	4.10	4.35	3.60	4.80	4.98	4.89	4.89	4.21
1913	2.14	2.83	2.25	2.85	1.78	1.24	3.04	2.72	2.61	3.07	1.97
1914	4.90	5.20	4.00	5.30	4.00	2.90	5.10	5.80	4.80	5.70	4.50
1915	2.55	2.78	2.70	3.20	2.90	2.80	3.50	3.70	3.90	3.70	3.67
Average	3.57	3.97	3.70	3.98	3.41	3.06	4.16	4.23	4.08	4.33	3.75
1916	1.60	1.70	2.10	1.40	1.70	1.30	2.50	2.20	2.10	2.20	1.90
1917	3.35	3.46	3.00	3.60	3.30	2.60	3.60	4.00	3.50	4.47	3.57
1918	1.19	1.45	1.05	1.19	0.76	0.45	1.45	1.38	1.49	1.25	0.97
1919	3.77	4.08	2.53	3.27	2.01	1.39	3.77	3.87	4.04	3.60	2.95
1920	3.06	3.09	2.99	3.60	3.23	2.89	3.02	3.23	3.04	3.91	3.41
1921	-	-	-	-	-	-	-	-	-	-	-
1922	6.30	6.30	5.80	5.70	4.06	4.00	5.70	6.20	6.00	5.70	4.50
1923	3.00	3.84	2.78	3.20	2.31	1.35	2.50	2.74	2.89	3.16	2.04
Average	3.18	3.42	2.89	3.14	2.48	2.00	3.22	3.37	3.29	3.47	2.76
1924	2.85	3.80	2.48	3.50	2.10	1.53	3.10	3.19	2.50	2.92	1.87
1925	1.70	1.80	1.25	1.40	0.95	0.68	1.48	1.40	1.50	1.50	1.19
1926	3.80	4.42	4.04	4.50	2.68	2.44	4.35	4.65	4.00	5.03	3.50
1927	1.87	2.10	1.50	1.80	1.30	1.02	2.00	2.17	1.87	1.60	1.08
1928	3.19	3.50	3.00	3.60	2.90	1.66	2.99	3.60	3.12	3.90	2.75
1929	2.17	2.78	2.68	2.68	2.17	1.66	2.30	2.55	2.10	2.50	2.27
1930	2.30	3.00	2.50	3.10	2.00	1.50	2.60	3.30	3.20	3.00	2.50
Average	2.55	3.06	2.49	2.94	2.01	1.50	2.69	2.98	2.61	2.92	2.17
Average, 1909-1930: 2/	3.10	3.48	3.03	3.35	2.64	2.19	3.36	3.53	3.33	3.57	2.89

The following kinds of fertilizers were used at the following rates per acre:
N (Nitrogen) for the first 9 years, 1909-1917, Nitrate of soda, 100 pounds; Dried blood, 400 pounds. For the last 13 years, 1918-1930, 40 pounds of nitrogen, all carried in nitrate of soda.
P (Phosphorous) Acid phosphate, 300 pounds.
K (Potash) Sulphate of potash, 200 pounds.
L (Lime) Every third year, 2,000 pounds.

1/ Gladwin, Fred E., A Test of Commercial Fertilizers for Grapes, N. Y. Agricultural Experiment Station, Bull. No. 458. 1919. (Data from 1919-1930 furnished by Mr. Gladwin.)
2/ Does not include the year 1921.

Table 11. - For a given fertilizer application the average increase in yield for Chautauqua-Erie vineyards on light-textured soils compared with increase in yield on Fredonia test plats

Plant food	Quantity per acre	Increased grape yields per acre	
		Chautauqua-Erie vineyards, 1928 1/	Fredonia test plats, 1909-1930 2/
	Pounds	Pounds	Pounds
Nitrogen	47	1273	1627
Phosphoric acid	42	777	227
Potash	96	582	787
Total	185	2632	2641

1/ Calculated from the regression equation for the light-textured soils; table 9.
2/ Calculated from averages of test plats given in table 10.

Plant food	Plat	Increased yield over check	Plat	Increased yield over check	Average
	Number	Tons	Number	Tons	Tons
N. K.	4	1.16	10	1.38	
N. P.	3	.84	9	1.14	
K exceeds P by		.32		.24	.28
N.K.	4	1.16	10	1.38	
P.K.	5	.45	11	.70	
N exceeds P by		.71		.68	.70
N.P.K.	2	1.29	8	1.34	1.32

Let "P" equal the increase in tons of grapes per acre due to the application of 42 pounds of phosphoric acid. Then the increase in yield due to the application of 47 pounds of nitrogen is equal to P + .70 tons; the increase due to 96 pounds of potash is equal to P + .28 tons. The total increase due to the application of the three kinds of plant food was equal to 1.32 tons per acre. Therefore

$$1.32 \text{ tons} = (P + .70 \text{ tons}) + P + (P + .28 \text{ tons})$$

$$P = .11\ 1/3 \text{ tons}$$

Phosphoric acid was much more effective, apparently, in increasing grape yields on the Chautauqua-Erie vineyards than on the Fredonia test plats, and potash was more effective on the test plats than on the vineyards.

There is more or less variability in the natural productiveness of different plats in the same field. The authors mention that the west portion of the vineyard including plats 2 and 3 was in poor condition. Phosphorous was applied to both of these plats. Besides, plat 10 was unusually productive, having the highest average yield. Nitrogen and potassium were applied to this plat. Other plats that received the same applications of nitrogen and potassium as plat 10, and in addition phosphoric acid, did not yield as well as plat 10. If corrections could be made for the differences in the natural productiveness of the different plats the test results for phosphorous and potash would probably agree with the experiences of the Chautauqua-Erie growers.

In addition to the vineyard at the Fredonia laboratory, fertilizer tests were made in six other vineyards selected according to differences in soil types and altitudes. 4/

Yields from 1910 to 1913 were reported for 5 of these vineyards which were described in Bulletin No. 381 of the New York Agricultural Experiment Station, as follows:

"The Miner vineyard is situated on a level piece of low-lying land on the Dunkirk clay type, which is as a rule much improved by under drainage."

"The Lee vineyard is a typical upland vineyard situated on the hillside south and east of Brocton. The soil is of the Dunkirk shale loam type and quite stony. The natural drainage is better than in many vineyards, owing in part to the slope, yet rock pockets keep parts of the land wet."

"The Barnes vineyard at Prospect Station is another upland vineyard situated on Dunkirk shale loam. It differs from the Lee vineyard in that it lies very level below a high ridge from which much seepage water gains access to it. It would be benefited by under drainage."

"The Grandin vineyard at Westfield, located in part on Dunkirk gravelly loam and the remainder on Dunkirk clay loam presents a well drained area succeeded by a wet one. Approximately two thirds of the length of the rows is on the Dunkirk clay loam while but one third is on the gravelly loam."

"The Hamilton vineyard, located at State Line and consisting of two acres, is situated on Dunkirk clay loam. This vineyard is wet. Much seepage water from the hills above rises to the surface over it."

The authors summarize the tests on these vineyards as follows: "The data in the cooperative work with commercial fertilizers, stable manure and green manures are confusing and unsatisfactory. Unsatisfactory because of the great variability of the results from the treatments in any one vineyard or in the several vineyards compared with one another. Taken as a whole they do not corroborate the work in the station vineyard at Fredonia."

4/ Hedrick, U. P., and Gladwin, F. E. A Test of Commercial Fertilizers for Grapes, New York Agricultural Experiment Station, Bull. No. 381. Geneva, 1914.

Results from the Miner and Barnes vineyards are given in table 12. At 1928 prices, the increased yields did not pay for the fertilizers. The largest losses, usually over $20 per acre, occurred when all 3 plant foods were applied. The fertilizer costs were high because dried blood was used at the rate of 400 pounds per acre. None of the interviewed growers bought dried blood, except as it was included in mixed goods.

The increased yield at the Fredonia laboratory vineyard more than paid for the fertilizer in all the tests but one. The chances that the differences in yield between the fertilized and unfertilized plats in the Fredonia laboratory vineyard experiment might occur by chance are remote. However, for most of the fertilizer tests on the other vineyards reported for 4 years the differences are not very significant, for such differences could frequently occur by chance. (table 12.)

The results of the fertilizer tests by Mr. Gladwin and the experiences of the Chautauqua-Erie grape growers, as summarized in this study, indicate that, at 1928 prices, fertilizers in the Chautauqua-Erie belt cannot be profitably applied to vineyards located on poorly drained soils, but can be profitably applied to vineyards located on well-drained soils. It is assumed that the important difference between the light- and heavy-textured soils in the Chautauqua-Erie belt is one of drainage. Further studies and experiments should be made to give a better understanding of the differences between these soils.

Grape yields on the Fredonia laboratory test plats have been declining. (table 13.) During the last 7 years, 1924-1930, the unfertilized plat yielded only about one half as much as during the first 7 years of the experiment. On the fertilized plats the decline in yield was less, varying from 26 to 42 percent. The increase in yield on the fertilized plats over the check plat was therefore greater during the last 7-year period than in the earlier periods. The plats receiving each kind of fertilizer - nitrogen, phosphorous, and potash - maintained yield better than did the other plats.

Relation of Use to Yields, Michigan Vineyards

Although lack of drainage limits the production in the Chautauqua-Erie belt, excessive drainage limits the production in southwestern Michigan. The soils about Lawton and Mattawan, Michigan, were mapped chiefly as Coloma sandy loam or Plainfield sand. These soils are so open and porous that their moisture-holding capacity is low. The yields of vineyards on these soils average less than the yields of the vineyards west of Paw Paw, which were on Fox sandy loam, where the drainage is adequate but not excessive.

Not enough vineyards were studied in Michigan to permit averaging those that received the same fertilizer treatment in 1927 and 1928, as was done for the Chautauqua-Erie vineyards in table 8. The Michigan vineyards were sorted according to the average application of nitrogen in 1927 and 1928. (table 14.) If the application in 1927 was not reported, the 1928 fertilizer application was used in the computations.

Table 12. - Summary of fertilizer tests at the Fredonia laboratory and other Chautauqua County vineyards

Soil type	Plant food per acre: Nitrogen	Plant food per acre: Phosphoric acid	Plant food per acre: Potash	Grape yields per acre	Increase over check yield: Tons	Increase over check yield: Percent	Value of increase over fertilizer cost at 1928 prices 1/	Chance occurences in 100 trials 2/
	Pounds	Pounds	Pounds	Tons	Tons	Percent	Dollars	Number
	3/ 56	42	96	3.23	1.04	47	- 3	Less than 1
Dunkirk gravelly loam 4/	56	42	96	3.51	1.32	60	+ 3	" " "
	56	42	0	3.18	.99	45	+ 2	" " "
	56	0	96	3.46	1.27	58	+ 5	" " "
	0	42	96	2.76	.57	26	+ 3	" " "
			MINER VINEYARD, DUNKIRK, 1910-1913					
	3/ 56	42	96	1.89	.08	4	-24	83
Dunkirk clay loam 5/	56	42	96	1.70	-.11	-6	-28	54
	56	42	0	1.90	.09	5	-18	74
	56	0	96	2.06	.42	26	-14	14
	0	42	96	1.74	.10	6	- 7	15
			BARNES VINEYARD, PROSPECT STATION, 1910-1913					
Dunkirk shale loam	3/ 56	42	96	1.65	.33	25	-19	15
	56	42	96	1.41	.06	4	-25	65
	56	42	96	1.78	.24	16	-21	25
Upland vineyard 5/	3/ 0	42	96	1.55	.23	17	- 4	40
	3/ 0	42	96	1.31	-.05	- 4	-11	60
	3/ 0	42	96	1.77	.23	15	- 4	15

1/ Fertilizer applications were charged as follows: Sodium nitrate, 100 pounds $2.94; dried blood, 400 pounds $13.49; acid phosphate, 300 pounds, $2.79; sulphate of potash, 200 pounds, $5.70. For cost of application, $1 per acre was added. Grapes were valued on the vine at $22 per ton.

2/ Number of times out of 100 that an increase in yield as great as indicated would occur from chance alone. This measure of the significance of the difference in yields is taken from R. A. Fisher, Statistical Methods for Research Workers, Edition 3, table 4, p. 139. Values of "t" are calculated from the difference in yield each year according to the formula $t = \frac{\bar{x}\sqrt{n'}}{s}$ where $\bar{x}$ is the mean difference in yield between the fertilized and the check plats, n' is the number of years recorded, and s is the standard deviation of the differences between the fertilized and check plats.

3/ Lime was applied every third year at the rate of 2,000 pounds per acre. No charge was made for lime.

4/ Data reported in table 10.

5/ Hedrick, U. P. and Gladwin, F. E. A Test of Commercial Fertilizers for grapes. New York Agricultural Experiment Station, Bull. No. 381. Geneva, 1914.

Table 13. - Grape yields averaged by 7-year periods from the fertilizer test plats on the Fredonia laboratory vineyard, 1909-1930 1/

Years	No fertilizer (Plat 6)	P. K. Plats 5 and 11	N. P. Plats 3 and 9	N. K. Plats 4 and 10	N. P. K. Plats 2 and 8
	YIELDS PER ACRE				
	Tons	Tons	Tons	Tons	Tons
1909 - 1915	3.06	3.58	3.89	4.16	4.10
1916 - 1923 2/	2.00	2.62	3.09	3.30	3.40
1924 - 1930	1.50	2.09	2.55	2.93	3.02
	RELATIVE YIELDS				
	Percent	Percent	Percent	Percent	Percent
1909 - 1915	100	100	100	100	100
1916 - 1923 2/	65	73	79	79	83
1924 - 1930	49	58	66	70	74
	DECREASE IN YIELD OVER PRECEDING 7-YEAR PERIOD				
	Tons	Tons	Tons	Tons	Tons
1916 - 1923 2/	1.06	.96	.80	.86	.70
1924 - 1930	.50	.53	.54	.37	.38

1/ Averages as given in table 10.
2/ The year 1921 is omitted.

Table 14. - Fertilizer applications in terms of plant food, and grape yields, on Michigan vineyards studied, by soil type, 1928

Soil type	Plant food per acre: Nitrogen	Phosphoric acid	Potash	Concord grapes: Yield per acre	Acreage per farm	Return per hour of labor	Vineyards
	Pounds	Pounds	Pounds	Tons	Acres	Cents	Number
Fox, Bellefontaine, sandy loam, and loam soils	0	0	0	2.09	18	14	28
	11	3	2	2.35	27	22	21
Coloma sandy loam, Plainfield sand	1/ 3	0	0	1.49	27	18	21
	2/ 21	1	1	1.74	30	20	22

1/ Includes vineyards receiving less than 10 parts of nitrogen per acre.
2/ Includes vineyards receiving 10 or more parts of nitrogen.

In Michigan, the fertilized vineyards yielded on the average about one fourth of a ton more per acre than did those that were not fertilized or that were fertilized very little. The increased yield averaged about the same for the vineyards on the sandy soils about Lawton and Mattawan as for the vineyards on the Fox sandy loam soil west of Paw Paw. The return per hour of man labor averaged more for the fertilized vineyards that for those not fertilized.

Fertilizer tests by Dr. Partridge on Michigan vineyards in which nitrogen was applied in different quantities and in combination with phosphorous and potassium on a very productive vineyard on the Fox sandy loam soil are given in table 15. On the average the vineyards on the fertilized plats yielded at the rate of .26 of a ton more per acre than the unfertilized plats. At 1928 prices, the value of the increased yield exceeded the cost of the fertilizer in only 1 of the 8 test plats. The largest losses were on plats fertilized the heaviest. The plat not fertilized yielded at the rate of over 4 tons of grapes per acre in 1922, 1923, and 1924. At 1928 prices, fertilizers did not pay on such a vigorous and productive vineyard.

Another experiment was reported by Partridge and Veatch on the Barrett vineyard situated largely on a Plainfield loamy sand soil. (table 15.) The check plats on this vineyard from 1924 to 1929 yielded at the rate of 2.26 tons per acre. The yields for 3 of the 6 fertilized plats exceeded the check yields by more than 1 ton per acre. At 1928 prices, the value of the increased yield exceeded the cost of the fertilizer for each of the trials. For 3 of the 6 fertilized plats there was a gain above the cost of fertilizer when nitrate was used alone or in combination with phosphorous or potassium of from $12 to $13 per acre. This test indicates that fertilizers are very profitably applied to vineyards like the Barrett vineyard.

Erosion in vineyards in Michigan is much more serious than in New York and Pennsylvania. Although the Barrett vineyard is relatively level, the authors state that there has been considerable loss of soil by surface washing since the vines were planted. According to the operator the soil is "going down" and a certain amount of root pruning is inevitable each year. The humus or organic matter in the surface soils was indicated by the depth of the humus layer. On the 4-acre block used for the fertilizer test the depth of the humus layer of the surface soil varied from less than 3 inches to over 9 inches. It is interesting to note how important these variations in the depth of the surface soil were in determining yields in this vineyard. (table 16.) The authors arrive at the conclusion that production is enhanced as much by planting vines on soils with humus layers 3 or 4 inches thick as it is by heavy annual applications of inorganic fertilizers made at large expense. These data suggest the importance of setting vineyards on deep soil and of preventing the washing away of this soil.

The vines in the Barrett vineyard were classified according to their initial vigor as measured by the pounds of wood trimmed per vine in 1923. The weak-growing vines were usually on soils of a thin humus layer; the vigor of vine growth was closely associated with thickness of the humus layer.

At the beginning of this experiment in 1923, one half pound or less per vine, of 1- and 2-year old wood was removed from 151 vines and 1.6 pounds and more per vine from 75 vines. The increase in yield from 1924 to 1929 averaged 1.32 tons per acre for the 151 vines on the fertilized plats compared with .63 ton per acre for the 75 vines on the unfertilized plats. (table 17.)

Table 15. - Summary of fertilizer tests on Michigan vineyards

Years and soil types	Plant food per acre: Nitrogen	Plant food per acre: Phosphoric acid	Plant food per acre: Potash	Grape yields per acre	Increase in grape yield over check yield (acre basis)		Value of increase in yield per acre over fertilizer cost at 1928 prices 1/	Chance occurrence in 100 trials 2/
	Pounds	Pounds	Pounds	Tons	Tons	Percent	Dollars	Number
1922-1925 3/ Fox sandy, loam soil	25	0	0	3.65	.19	5	-2	54
	25	70	0	3.71	.25	7	-5	23
	25	0	109	3.83	.37	11	-3	18
	25	70	109	3.80	.34	10	-8	26
1922-1925 4/ Fox sandy, loam soil	17	0	0	3.27	.18	6	0	49
	34	0	0	3.56	.47	15	3	15
	51	0	0	3.34	.25	8	-5	54
	67	0	0	3.12	.03	1	-13	90
1924-1929 5/ Plainfield, loamy sand	34	0	0	3.14	.88	39	12	46
	34	70	0	3.30	1.14	53	13	37
	34	0	109	3.26	1.10	51	12	46
	34	70	109	3.36	1.20	56	9	16
	34	0	0	2.98	.63	27	8	63
	34	0	0	2.72	.37	16	2	77

1/ Fertilizer prices per ton used as given in table 1; Sodium nitrate, $58.74; ammonium sulphate, $59.29; acid phosphate, $21.24; potassium chloride, $46.25. As estimated cost of applying fertilizer $1 per acre was added. Grapes were valued at $22 per ton on the vines.

2/ See footnote 2, table 12.

3/ Partridge, N. L., Cultural Methods in the Bearing Vineyard, Michigan Agricultural Experiment Station, Circular Bulletin No. 130. 1930. Table 1, p. 9 Fertilizers were applied at the following rates on an acre basis; Nitrate of soda, 163 pounds; acid phosphate, 16 percent, 435 pounds and potassium chloride, 218 pounds per acre.

4/ Partridge, N. L., Cultural Methods in the Bearing Vineyard Michigan Agricultural Experiment Station, Circular Bulletin No. 130.Table IV, p. 11. Sodium nitrate was applied at the following rates on an acre basis, 109,218, 326, and 435 pounds.

5/ Partridge, N. L. and Veatch, J. O., Fertilizers and Soils in Relation to Concord Grapes in Southwestern Michigan. Michigan Agricultural Experiment Station, Tech. Bull. No. 114. 1931. Table 9, p. 36. Fertilizers were applied at the following rates on an acre basis: Nitrate of soda, 217.5 pounds, acid phosphate, 435 pounds and muriate of potash 217.5 pounds. In the last two trials nitrogen was applied in the form of ammonium sulphate, 163 pounds per acre. In the last trial ground limestone was also applied.

Table 16. - Depth of humus layer of surface soil and 1923 grape yields, Barrett vineyard, Lawton, Michigan 1/

Depth of humus layer (inches)	Vines	Average yield per acre
	Number	Tons
Under 3	132	0.59
3 to 5	850	1.02
6 to 9	564	1.46
Over 9	73	2.20
Total or average	1619	1.20

1/ Partridge, N. L. and Veatch, J. O. Fertilizers and Soils in Relation to Concord Grapes in Southwestern Michigan. Michigan Agricultural Experiment Station Tech. Bull. No. 114. 1931. p. 33, table 6.

Table 17. - Results from fertilizer applied to weak and vigorous growing vines, Barrett vineyard, Lawton, Michigan, 1924-1929 1/

Weight of prunings, 1923 (pounds per vine)	Grape yields per acre (check plats)	Increase in yield over check plats for plats fertilized as indicated 2/					
		Ammonium	Nitrate	Nitrate phosphate	Nitrate potash	Nitrate phosphate potash	Average all plats
	Tons	Tons	Tons	Tons	Tons	Tons	Tons
0.1 to 0.5	1.22	0.89	1.02	1.65	1.53	1.49	1.32
0.6 to 1.0	2.10	.55	.79	1.21	1.21	1.41	1.03
1.1 to 1.5	2.71	.43	.88	1.17	1.28	1.33	1.04
1.6 and over	3.46	.55	.41	.82	.64	.73	.63
Average	2.37	.60	.80	1.21	1.16	1.24	1.00

Value per acre of increased yield over cost of fertilizer - 2/ at 1928 prices 3/

	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
0.1 to 0.5	14	15	24	21	16	18
0.6 to 1.0	8	10	15	14	14	13
1.1 to 1.5	4	14	14	16	12	8
1.6 and over	6	2	6	2	-1	3
Average	8	10	15	13	10	10

1/ Adapted from table 10, page 37, Michigan Agricultural Experiment Station, Tech. Bull. No. 114.
2/ See footnote 4, table 15, for rates of applying fertilizer.
3/ See footnote 1, table 15, for prices of fertilizer and grapes.

In this vineyard a given quantity of fertilizer applied to the weakest growing vines produced about twice as many grapes as when applied to the strongest growing vines. At 1928 prices, the value per acre of the increase in grape yield over the cost of fertilizer, averaged $18 for the weakest growing vines compared with $3 for the strongest growing vines. In this vineyard, at 1928 prices, it probably paid to fertilize all vines but it paid about 5 times better to fertilize the weakest vines than it did to fertilize the strongest vines.

At 1928 prices, the most profitable fertilizer application used on the Barrett vineyard was 218 pounds of sodium nitrate and 435 pounds of acid phosphate. The value per acre of the increased yield over the cost of fertilizer was $15, compared with $10 when nitrate was used alone. The use of nitrate of soda was slightly more profitable than the use of ammonium sulphate.

Of the 91 Michigan interviewed growers, only 8 applied any phosphoric acid to their vineyards in 1928 and none of these applied as heavy an application as was used in the test on the Barrett vineyard.

On the Barrett vineyard 218 pounds of sodium nitrate and 218 pounds of muriate of potash gave increased yields about equal to the nitrate-phosphate combination, which was about 50 percent greater than the gains in yield when nitrate was applied alone. At 1928 prices the nitrate potash combination did not pay as well as the nitrate phosphate combination but paid better than when nitrate was used alone. When both phosphate and potash were combined with nitrate, the yields were not increased over the nitrate phosphate or nitrate potash combinations.

Only 6 of the 91 Michigan growers interviewed applied potash to their vineyards in 1928. The growers about Paw Paw, Lawton, and Mattawan when fertilizing vineyards, have generally applied small quantities of ammonium sulphate. According to the averages obtained for 1928, this method of fertilization, on the average, has not greatly increased yields or profits.

The Michigan fertilizer plat tests, like those in New York, emphasize how differently various vineyards respond to fertilizer applications. In Dr. Partridge's tests the increased yield due to fertilizer was about 4 times as much on the Plainfield soil type as on the Fox soils. That growers on the Coloma and Plainfield soils have had better results with fertilizers than growers on the Fox and Bellefontaine soils may be indicated by the fact that 65 percent of the vineyards studied on the Coloma and Plainfield soils and only 43 percent of the vineyards studied on the Fox and Bellefontaine soils were fertilized in 1928. When fertilized, the Coloma and Plainfield vineyards were fertilized heavier on the average than the Fox and Bellefontaine vineyards. However, the differences in increased yield in 1928 between fertilized and unfertilized vineyards were not so great for vineyards on the Coloma and Plainfield soils as would be expected.

Costs, by Areas

Grape yields and production costs for vineyards fertilized and for those not fertilized in 1928, the year for which this study was made, are given in table 18. This comparison is not entirely satisfactory because only a part of the increased yield derived from fertilizer was obtained in the year the fertilizer was applied.

Table 18. - Fertilizer costs, grape yields, production costs, and returns per hour of labor, averages by areas, 1928

Area	Cost per acre		Vineyards	Grape yields per acre	Cost per ton of grapes		Return per hour of labor	Value of land per acre
	Cost of fertilizer 1/	Growing grapes (excluding picking and marketing)			Growing (excluding picking and marketing)	Total		
	Dollars	Dollars	Number	Tons	Dollars	Dollars	Cents	Dollars
Chautauqua-Erie Light-texture soils	0.0	72.63	18	1.71	42.54	56.88	13	225
	6.88	80.40	47	2.16	37.18	50.17	18	242
	13.23	98.81	31	2.41	41.07	52.99	16	261
Heavy-texture soils	0.0	68.39	58	1.54	44.36	57.33	6	129
	6.09	75.52	56	1.65	45.81	59.60	3	123
Hudson Valley	0.0	151.17	10	2.21	68.46	82.92	28	283
	8.16	126.95	25	2.51	50.50	68.29	26	280
Michigan Fox, Bellefontaine	0.0	63.48	33	2.06	30.79	43.72	15	85
	2.75	64.61	16	2.30	28.07	39.20	21	101
Coloma, Plainfield	0.0	49.44	18	1.57	31.54	44.61	20	61
	3.29	57.48	25	1.60	35.91	49.96	19	69
Finger Lakes, (Exclusive of Seneca Co.)	0.0	69.91	54	1.41	49.69	62.89	14	86
	3.03	72.73	43	1.40	51.90	65.66	19	78
Arkansas (1929)	0.0	59.75	64	1.49	39.99	57.85	10	107
	2.79	60.79	14	1.28	47.41	57.80	-2	96

1/ Records for the light-texture soils were sorted into three groups: Those using no fertilizer, those using less than $10 worth per acre, and those using $10 worth or more per acre. All the other records for the different areas were sorted in two groups - those using and those not using fertilizer during the year for which the cost data were obtained.

MANURE

Extent Used

For vineyards studied around Girard, Pa., only about 1 grower in 5 applied manure to his vineyard in 1928. (table 19.) Manure was probably more profitably used on potatoes, tomatoes, melons, asparagus, and other cash crops which were extensively grown around Girard. Of all the areas studied, on the average, the least manure but the most commercial fertilizer was applied to Girard vineyards.

Table 19. - Use of manure on vineyards, by areas, 1928

Area	Vineyards manured	Percentage of grape acreage that was manured	Quantity applied per acre manured	Value per ton at barn	Percentage of manure used that was produced on farms studied
	Percent	Percent	Tons	Dollars	Percent
Hudson Valley, N.Y.	60.0	29.5	3.5	5.28	45.0
Niagara County,N.Y.	55.0	24.3	8.0	2.51	100.0
Chautauqua Co.,N.Y.	75.4	22.6	4.7	2.70	99.9
Michigan	63.0	21.5	3.8	1.84	93.9
North East, Pa.	61.3	15.5	4.6	3.63	100.0
Finger Lakes, N.Y.	65.5	13.6	7.5	1.76	96.9
Arkansas (1929)	43.6	12.6	4.6	1.53	68.9
Girard, Pa.	19.2	10.3	3.1	2.14	90.6
Average	60.6	18.8	4.8	2.48	93.7

For the year the study was made, in Arkansas, 2 farmers in 5 applied manure to their vineyards. In all areas, except Girard and Arkansas, a majority of the growers applied manure to some part of their vineyards. On the average for all areas, about 1 acre out of 5 was manured during the year. For every acre manured 2.4 acres were fertilized. Niagara County was the only area studied where the acres of vineyard manured exceeded the acres fertilized.

Two thirds of the growers applying manure to their vineyards applied manure each year for 5 years. (table 20.) Usually only a part of the vineyard was manured each year. Manure was usually produced on the farm where used. An exception in the Hudson Valley occurred where 6 of the 35 growers visited, purchased 201 tons of manure for vineyard use at a cost of $5.24 per ton. Four growers in Arkansas also bought for vineyard use, 192 tons of manure at $ .95 per ton. In the other areas studied, over 90 percent of the manure used on grapes was produced on the farm where used.

On the average, the value of manure at the barn was estimated by the growers at $2.48 per ton. (table 19.) Relatively little manure was produced on most grape farms and for this reason was probably valued higher than it would be on stock farms.

Table 20 - Vineyards manured during 5-year period, 1924-1929, by areas

Area	Vineyards manured						Percentage of vineyards manured 1/
	0 year in 5	1 year in 5	2 years in 5	3 years in 5	4 years in 5	5 years in 5	
	Number	Number	Number	Number	Number	Number	Percent
Chautauqua Co., N.Y.	12	4	5	3	6	71	78.8
Michigan	6	2	6	1	3	33	73.4
Finger Lakes, N.Y.	16	9	9	3	4	56	66.9
North East, Pa.	10	4	2	2	-	30	64.7
Niagara Co., N.Y.	2	2	4	2	2	6	62.1
Hudson Valley, N.Y.	8	3	2	1	2	17	61.2
Arkansas (1925-1929)	9	10	8	5	4	11	45.2
Girard, Pa.	2	2	-	-	-	-	15.6
Total or average	65	36	36	17	21	224	65.7

1/ The sum of the years vineyards were manured was divided by the sum of the years vineyards were studied and the quotient was multiplied by 100. In addition to the 399 vineyards shown in this table for which manuring practices were reported for 5 years, there were included 154 other vineyards for which practices were reported for 1 to 4 years.

Cost of Use

About two thirds of the manure applied to vineyards was handled by a crew of 1 man and 2 horses. (Table 21.) This was the most economical crew. An extra man increased the cost of application per ton, and one horse was not as efficient as two.

Three fourths of the manure was handled in wagons and one fourth in spreaders. In a given length of time, 1 man and 2 horses handled with spreaders 55 percent more manure than with wagons. The cost of 1 man and 2 horses per ton of manure handled averaged $1.20 with wagons and $ .73 with spreaders. If the charge for the use of spreader did not exceed the charge for the use of the wagon by $ .46 per ton, then it was more economical to use a spreader. Many grape growers get along without a spreader because they have little manure. The usefulness of a spreader was limited in the interplanted vineyards in the Hudson Valley and in the vineyards on the steep hillsides in the Finger Lakes. In Michigan 40 percent and in Chautauqua County 15 percent of the growers who applied manure to their vineyards used spreaders.

Manure was charged to vineyards at what the grower estimated it was worth. The estimated value of the manure at the barn plus the cost of hauling and spreading averaged $3.67 per ton. At the average rate of 4.75 tons, the manure charge per acre averaged $17.43. The cost of fertilizer per acre fertilized was only $7.58 or less than half the manure charge. But the fertilizer had to be bought whereas the manure was largely produced on the farm.

Table 21. - Average quantity of labor and cost of labor and power used in applying a ton of manure with wagon and with spreader, by crews, all vineyards, 1928 1/

Crew	Wagon	Spreader	Total or average
	PROPORTION OF MANURE APPLIED WITH WAGON AND SPREADER		
	Percent	Percent	Percent
1 man - 1 horse	6.2	-	6.2
1 man - 2 horses	45.2	19.5	64.7
2 men - 2 horses	12.2	4.2	16.4
Other crews	11.7	1.0	12.7
All crews	75.3	24.7	100.0
	MANURE APPLIED PER ACRE		
	Tons	Tons	Tons
1 man - 1 horse	3.84	-	3.84
1 man - 2 horses	4.85	5.00	4.90
2 men - 2 horses	4.84	4.58	4.77
Other crews	4.79	3.02	4.58
All crews	4.74	4.80	4.75
	MAN LABOR PER TON OF MANURE		
	Hours	Hours	Hours
1 man - 1 horse	2.5	-	2.5
1 man - 2 horses	1.4	0.9	1.2
2 men - 2 horses	2.1	1.2	1.9
Other crews	2.2	1.8	2.1
All crews	1.7	1.0	1.5
	COST PER TON OF MAN LABOR AND HORSE WORK		
	Dollars	Dollars	Dollars
1 man - 1 horse	2.02	-	2.02
1 man - 2 horses	1.20	0.73	1.06
2 men - 2 horses	1.41	0.84	1.26
Other crews	2/ 1.34	3/ 1.47	2/ 1.35
All crews	2/ 1.32	3/ 0.78	2/ 1.19

1/ Data for Arkansas are for the year 1929.
2/ Includes a small cost for some use of truck and tractor.
3/ Includes a small cost for some use of tractor.

To measure the quantity of manure applied per acre, the total tons applied were divided by the total acres in vineyard, including both the acres manured and not manured. According to this measure there were 60 vineyards, or 11 percent, on which the average quantity of manure per acre amounted to 3 tons or more. For those vineyards which received the most manure, the average cost per ton of grapes exceeded the cost for vineyards that received no manure by $9.69 per ton, an increased cost of 27 percent. The return per hour of labor averaged 23 cents for vineyards that received no manure compared with 11 cents for vineyards receiving 3 tons or more of manure. For each of the 11 areas or soil types given in table 22, the group of vineyards treated with little or no manure had the lowest growing costs per ton of grapes and the highest returns per hour of labor.

As has been shown, the fertility practice in a given year tends to be the one usually followed on that farm. For this reason, all of the manure and fertilizer used during the year were included in the cost.

Probably the vineyards not manured tended to be on somewhat better land than the manured vineyards. The value of the land averaged $146 per acre for the non-manured vineyards and $114 for the vineyards that received the most manure. The tendency would be to keep more livestock on the farms not so well adapted to fruit.

Effect on Grape Yields

For all areas except Arkansas, growers who did not apply manure, did apply large applications of commercial fertilizers, amounting on the average to 22 pounds of nitrogen per acre. (table 23.) Growers using the most manure used the least fertilizer, an average of but 6.3 pounds of nitrogen per acre.

For those vineyards where little or no commercial fertilizer was used, an application of 3 tons or more of manure per acre increased the yield about 6 percent. Out of 271 vineyards fertilized and manured approximately the same in 1927 as in 1928, there were only 9 vineyards which received relatively heavy applications of both manure and fertilizer. The applications on these 9 vineyards averaged 5.67 tons of manure per acre and 19.8 pounds of nitrogen in the form of commercial fertilizer. The average yield for these 9 vineyards was 16 percent above the average. The yields for the 64 vineyards receiving no manure and 30.4 pounds of nitrogen in commercial fertilizers, were 9 percent above the average.

COVER CROPS

Extent of Use

The vicinity of Girard, Pa., was the only area studied where most of the vineyard acreage was seeded to cover crops in 1928. Seventy-six percent of the Girard acreage was thus seeded. (table 24.)

In the North East, Pa., and Michigan areas, about 3 acres out of 10 were seeded to cover crops in 1928; in the Chautauqua Co., N.Y., Arkansas, and the Hudson Valley areas about 2 acres out of 10 were seeded. Little seeding of cover crops was done in the Finger Lakes area, and no seeding was done in 1928 on the 20 vineyards studied in Niagara County, N. Y.

Table 22. - Relation of quantity of manure used per acre of vineyard to average grape yields, costs, and return per hour of labor, by areas, 1928

Area and application of manure (tons per acre)	Average quantity of manure per acre	Grape yields per acre	Cost of fertilizer, manure and cover crop per acre	Cost of growing grapes (excluding picking and marketing) Per acre	Cost of growing grapes (excluding picking and marketing) Per ton 1/	Return per hour of labor	Vineyards
Chautauqua Co., N.Y.:	Tons	Tons	Dollars	Dollars	Dollars	Cents	Number
Lakes Plain soils							
No manure	0.0	1.97	6.02	74.16	37.57	16	17
Less than 1.0	.51	1.59	6.37	71.59	45.02	6	31
1.0 to 2.99	1.64	1.71	12.10	83.85	49.10	-1	24
3.0 and over	4.19	1.72	16.02	80.98	46.96	-5	13
Hill soils							
Less than 1.0	.26	1.39	3.84	68.47	49.33	6	16
1.0 and over	1.85	1.35	11.95	72.88	53.95	-8	13
Girard, Pa.							
No manure	0.0	2.46	15.24	88.96	36.12	35	17
Manure	1.32	2.23	19.89	86.78	38.94	32	5
North East, Pa.							
Lake Plain soils							
No manure	0.0	2.48	10.80	82.63	33.29	25	22
Less than 1.0	.53	2.09	13.00	87.01	41.55	2	20
1.0 and over	2.32	2.01	22.55	91.25	45.31	6	13
Hill soils							
Less than 1.0	.43	1.52	7.50	57.71	37.95	24	12
1.0 and over	1.91	1.64	14.91	77.50	47.22	1	8
Michigan							
Loam soils							
Less than 1.0	.34	2.14	3.39	57.74	26.97	25	22
1.0 and over	2.66	2.20	9.32	73.04	33.18	11	27
Sandy soils							
No manure	0.0	1.70	2.95	50.08	29.42	28	20
Manure	.76	1.50	5.94	58.24	38.76	11	23
Arkansas (1929)							
No manure	0.0	1.39	1.27	55.94	40.28	12	44
Manure	1.07	1.44	4.84	63.69	44.22	4	34
Hudson Valley, N.Y.							
No manure	0.0	2.73	13.91	128.37	46.97	30	14
Manure	1.70	2.26	14.15	133.89	59.19	25	21
Niagara Co., N.Y.							
No manure	0.0	2.13	0.0	61.81	28.99	59	9
Manure	3.92	1.84	15.94	77.59	42.21	36	11
Ringer Lakes, N.Y.							
No manure	0.0	1.74	1.63	67.60	38.84	23	39
Less than 1.0	.60	1.24	4.95	69.37	55.89	12	26
1.0 to 2.99	1.68	1.56	8.82	73.19	46.82	15	30
3.0 and over	4.19	1.73	13.36	79.51	45.89	18	18
All areas							
No manure	0.0	1.93	5.29	68.52	35.46	23	214
Less than 1.0	.52	1.67	7.09	69.95	41.93	10	135
1.0 to 2.99	1.71	1.75	11.10	78.55	44.93	9	140
3.0 and over	4.60	1.87	16.60	84.58	45.15	11	60

1/ Averages worked through totals.

Table 23.-Relation of quantity of manure applied to yields of Concord grapes, per acre, 1927 and 1928 1/

Manure applied in 1927 and 1928 (tons per acre)	Average quantity of manure per acre	Average quantity of plant food in commercial fertilizer applied per acre: Nitrogen	Phosphoric acid	Potash	Vineyards	Concord yields, average per acre: 1927	1928	Yield relatives, 2-year average 1927-1928 2/
	Tons	Pounds	Pounds	Pounds	Number	Tons	Tons	Percent
ALL VINEYARDS								
No manure	0.0	22.0	26.1	16.1	89	1.68	2.28	103
Under 1.0	0.57	15.8	24.1	8.1	65	1.43	1.88	99
1.0 to 2.9	1.67	13.0	10.6	4.3	87	1.36	1.82	99
3.0 and over	4.95	6.3	4.2	4.0	30	1.48	2.05	101
Average or total	1.22	15.9	18.2	9.0	271	1.49	1.99	100
VINEYARDS THAT RECEIVED LESS THAN 10 POUNDS OF NITROGEN PER ACRE IN 1927 AND 1928 3/								
No manure	0.0	0.5	6.0	0.0	25	1.74	2.17	94
Under 1.0	0.57	1.8	12.5	0.8	25	1.41	1.78	97
1.0 to 2.9	1.71	1.2	3.0	2.0	39	1.30	1.69	95
3.0 and over	4.64	0.6	0.0	0.0	21	1.32	1.97	100
Average or total	1.62	1.0	5.3	0.9	110	1.42	1.84	96
VINEYARDS THAT RECEIVED 10 POUNDS AND OVER OF NITROGEN PER ACRE IN 1927 AND 1928 3/								
No manure	0.0	30.4	34.0	22.3	64	1.66	2.31	109
Under 1.0	0.56	24.6	31.3	12.6	40	1.46	1.96	105
1.0 to 2.9	1.63	22.7	16.7	6.1	48	1.42	1.93	105
3.0 and over	5.67	19.8	13.9	17.0	9	2.12	2.37	116
Average or total	0.94	26.0	27.1	14.8	161	1.54	2.10	107

1/ Includes each vineyard in all areas except Arkansas that received approximately the same manure and fertilizer treatment during both years, 1927 and 1928.

2/ The yield of each Concord vineyard 6 years old or older was expressed as a percentage of the average yield for the area or soil type in which the vineyard was located. The average yield was expressed as 100. To obtain the yield relatives shown in this table, the relatives for each vineyard were weighted by acreage.

3/ Refers to nitrogen in commercial fertilizers.

Many vineyards are seeded every year. Of all vineyards in all areas that were seeded for one or more years during the period, 1924-1928, 41 percent were seeded each of the 5 years.

Table 24. - Vineyards seeded to cover crops during 5-year period, 1924-1928, by areas

Area	Vineyards seeded to cover crops - 0 year in 5	1 year in 5	2 years in 5	3 years in 5	4 years in 5	5 years in 5	Percentage of vineyards seeded to cover crops During 5-year period 1924-1928 1/	Percentage of vineyard acreage seeded to cover crops In 1928
	Number	Number	Number	Number	Number	Number	Percent	Percent
Girard, Pa.	0	0	0	1	1	4	77.0	76.9	76.0
North East, Pa.	14	4	10	3	6	14	47.8	39.5	27.9
Michigan	11	2	3	4	2	12	43.2	30.4	30.8
Chautauqua Co., N.Y.	34	5	7	3	4	18	35.7	21.9	21.5
Arkansas 2/	20	7	4	2	1	8	32.0	25.6	18.6
Hudson Valley, N.Y.	12	1	1	1	1	2	19.3	17.1	17.6
Niagara Co., N.Y.	7	2	0	2	0	0	12.5	0.0	0.0
Finger Lakes, N.Y.	61	4	4	1	2	3	10.0	6.2	3.0
Total or average	159	25	29	17	17	61	32.0	24.5	23.1

1/ The sum of the years vineyards were seeded to cover crops was divided by the sum of the years vineyards were studied and the quotient was multiplied by 100. In addition to the 308 vineyards shown in this table for which cover crop data were reported for 5 years, there were included 246 other vineyards for which cover crop data were reported for 1 to 4 years.

2/ Data for Arkansas are for the year 1929 and for the 5-year period 1925-1929.

Kinds Used

For all vineyards studied, rye alone was used as a cover crop on 45 percent, and rye mixed with other seeds on 13 percent of the total acreage seeded (table 25.) Thirteen different kinds of cover crops were used in the vineyards studied. Next to rye, the most important crops were rape, vetch, and oats. Buckwheat was the most important cover crop in the Hudson Valley and in the Finger Lakes areas.

Many growers consider rye satisfactory as a cover crop. In the spring, rye competes with the grapevines for moisture and plant food, and is difficult to subdue if left too long, therefore, it should be turned under early.

The majority of the growers in all of the areas studied, except Girard, depend upon weeds for cover crops.

Table 25. - Kind of cover crops used on vineyards and the relative importance of each, by areas, 1928

Cover crop	Percentage of total acreage of cover crops in vineyards							
	Girard, Pa.	Michigan	North East, Pa.	Chautauqua Co., N.Y.	Arkansas (1929)	Hudson Valley, N.Y.	Finger Lakes, N.Y.	All areas
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Rye	65.8	40.2	54.7	25.5	77.6	3.2	15.1	45.0
Rye and vetch		16.8		8.9				7.1
Rye and oats		2.6	3.5					1.6
Rye, oats, and buckwheat				13.1				2.8
Rye and rape	3.0			3.5				1.1
Rye alone, or in combination	68.8	59.6	58.2	51.0	77.6	3.2	15.1	57.6
Rape	13.3		16.7	6.2				6.7
Rape and clover	8.0							1.0
Vetch		21.5						6.7
Vetch and wheat				1.9		33.3		1.2
Vetch and oats		0.5						0.2
Vetch, oats, and wheat		3.1						1.0
Oats		15.3	8.4	1.8				7.1
Oats and buckwheat			0.5	3.6				0.9
Millet	7.8		8.3	9.1				4.7
Millet and buckwheat				23.1				4.9
Buckwheat				0.8		63.5	84.9	3.6
Wheat			2.7	2.5	4.6			1.5
Cowpeas					15.3			1.2
Crimson clover			3.4					0.8
Clover			1.8					0.4
Clover and turnips	1.5							0.2
Turnips	0.6			-				0.1
Sudan grass and cane				2.5				0.2
Total	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Dates and Cost of Seeding

In 1928, a majority of the vineyard acreage seeded in Chautauqua Co., N.Y., and in Erie Co., Pa., was seeded the first week in August. (table 26.) Michigan growers did 49.4 percent of their seeding the first week in August.

Table 26. - Date of seeding cover crops by areas, 1928 1/

Month	Week	Percentage of cover-crop acreage that was seeded in indicated week				
		Michigan	Arkansas (1929)	Girard and North East, Pa.	Finger Lakes, N.Y.	Chautauqua County, N.Y.
		Percent	Percent	Percent	Percent	Percent
June	1st					
	2nd		3.7		10.8	
	3rd					
	4th		14.6			
July	1st		6.7		8.8	
	2nd				0.8	
	3rd	1.1			3.9	
	4th	13.2	.7	16.6	15.7	
August	1st	49.4		58.1	39.2	72.1
	2nd	21.3		11.7	10.8	8.4
	3rd	2.2		1.9		14.3
	4th	6.5		11.7		3.4
September	1st		29.2			
	2nd		10.9			1.8
	3rd		1.5			
	4th		4.4			
October	1st	1.8	22.6			
	2nd					
	3rd	4.5	5.7			
	4th					
Total		100.0	100.0	100.0	100.0	100.0

1/ Data not available for Hudson Valley, N.Y. In Niagara County, N.Y., no cover crops were seeded on the 20 vineyards studied in 1928.

Writing on Michigan conditions, Dr. Partridge says that if the cover crop is to make any considerable growth it should be sown before the 10th of August. The cover crop should usually be sown about the 1st of August but should be planted earlier in the summer when the grape crop is scanty and moisture is abundant. It should be planted later when the grape crop is excessive and moisture is scanty. 5/

5/ Partridge, N.L. Cultural Methods in the Bearing Vineyard. Michigan Agricultural Experiment Station, Circular Bulletin No. 123, 1930.

On the average 49 pounds of rye were used per acre. The cost of the rye seed averaged $1.09 per acre. The rate of seeding and cost of seed for other important cover crops are given in table 27. The average cost per acre of man labor and horse work used in applying cover crop seed varied from $ .74 for the Girard, Pa. vineyards to $1.51 for the Hudson Valley vineyards. (table 28.)

The average amount of man labor required per acre varied from 1 hour in Michigan to 2 hours in the Hudson Valley. In applying the seed the most common crew used was 1 man and 2 horses. It took such a crew an average of 1 hour at a cost of 84 cents per acre. The total cost of cover crop was relatively small. The seed and cost of application averaged about $2 per acre.

Table 27. - Average quantity and cost of cover-crop seed per acre of vineyard, by kind of cover crop, 1928 1/

Kind of cover crop	Vineyards	Quantity of seed per acre		Price per bushel	Cost of seed per acre
	Number	Pounds	Bushels	Dollars	Dollars
Rye	67	49	.88	1.24	1.09
Rye and vetch 2/	8	-	.80	1.27	1.02
Oats	12	38	1.18	.53	.63
Buckwheat	12	55	1.14	1.44	1.64
Oats and buckwheat	3	3/ 36	.97	.91	.88
Wheat	6	52	.86	1.39	1.20
Rape	8	7	.14	4.09	.57
Millet	7	26	.51	2.34	1.19
Cow Peas	4	11	.19	4.17	.79
Vetch	2	8	.14	9.62	1.35

1/ Arkansas 1929.
2/ Quantities of vetch and rye were not reported separately.
3/ For each of two of the vineyards, 18 pounds of oats and 18 pounds of buckwheat were seeded per acre.

Table 28. - Average quantity and cost of labor and power to seed an acre of vineyard to cover crops, by areas, 1928

Area	Vineyards	Quantity per acre: Man labor	Quantity per acre: Horse work	Cost per hour: Man labor	Cost per hour: Horse work	Cost of man labor and horse work per acre
	Number	Hours	Hours	Cents	Cents	Dollars
Girard, Pa.	20	1.1	0.7	45.0	21.9	1/ 0.74
Michigan	28	1.0	1.8	43.1	19.2	.78
Arkansas (1929)	19	1.5	2.4	26.5	15.1	1/ .79
Finger Lakes, N.Y.	7	1.7	.9	45.6	13.7	.90
Chautauqua Co., N.Y.	25	1.5	1.4	51.1	16.0	1/ 1.04
North East, Pa.	30	1.4	1.4	50.2	22.5	1/ 1.09
Hudson Valley, N.Y.	5	2.0	1.7	58.0	20.4	1.51
Total or average	134	1.3	1.5	46.5	19.2	2/ .93

1/ Includes some cost for use of tractor.
2/ Includes some cost for use of tractor, truck, and automobile.

Effect on Grape Yields

Vineyards seeded to cover crops for 5 consecutive years, 1924-1928, yielded in 1928 8 percent more than neighboring vineyards which had not been seeded to cover crops during the 5-year period. (table 29.) The 4-year average yields (1924-1927) for vineyards seeded to cover crops in each of the 5 years was 9 percent greater than for neighboring vineyards not seeded.

Table 29. - Relation of the use of cover crops to Concord yields on vineyards for which cover crop practices were reported during 5-year period, 1924-1928 1/

Years that vineyard was seeded during 5-year period, 1924-1928 (Number)	Vineyards	Relative Concord yields 2/	
		1924-1927	1928
	Number	Percent	Percent
None	159	97	97
1 to 2	54	91	99
3 to 4	34	107	100
5	61	106	105
Total or average	308	100	100

1/ The vineyards studied in Arkansas were for the 5-year period 1925-1929.
2/ Average yield per acre of vineyard receiving indicated cover-crop treatment divided by average yield of all vineyards.

INCREASE IN FERTILIZING PRACTICES, 1908-1928

An experimental vineyard laboratory was established at Fredonia, N.Y., in 1909, in charge of F. E. Gladwin, and the first work done by the staff was to interview 482 growers in Chautauqua County concerning their vineyard practices and problems.

For the vineyards studied, the proportion of growers using manure was about the same in 1908 as in 1928, 79 and 75 percent, respectively. (table 30. The proportion of growers using fertilizer had increased during the 20 years, 30 percent more growers having applied fertilizer to their vineyards in 1928 than in 1908. There was also a large increase in the practice of seeding vineyards to cover crops. Out of 100 vineyards, 14 vineyards in 1908 and 22 vineyards in 1928 were seeded.

Table 30. - Comparison of fertilizing practices on 482 vineyards studied in 1908 with 114 vineyards studied in 1928, Chautauqua County, N.Y. 1

Kind of treatment	Percentage of vineyards that were treated: 1908 (482 vineyards)	1928 (114 vineyards)	Increase or decrease from 1908 to 1928
	Percent	Percent	Percent
Commercial fertilizer	37	48	+ 30
Manure	79	75	- 5
Cover crop	14	22	+ 57

1/ The study in 1908 was made by F. E. Gladwin. Data contained in unpublished report entitled The Grape Survey of Chautauqua Area.

TOTAL FERTILITY COSTS AND RETURNS

For all vineyards studied, the cost per acre for fertilizer, manure, and cover crops seeded averaged $8.01. (table 31.) The average fertility cost per acre was lowest for Arkansas ($3.19) and highest for Girard ($15.75).

Materials - manure, fertilizer, and seed - amounted to $5.79 per acre which was equal to 72 percent of the fertility cost (table 32); 25 percent of the fertility cost was for applying the materials and 3 percent was for interest on costs.

Of the total cost of growing grapes up to picking time, fertility costs were 11.1 percent, varying from 5.3 percent for Arkansas to 17.9 percent for Girard. Relatively little time (less than 4 percent of all the time spent growing grapes excluding harvesting and marketing) was spent in applying manure, fertilizer, and cover-crop seed.

Table 31. - Average cost per acre of vineyard for fertilizing, manuring, and seeding to cover crops, and proportion these costs are of the total cost of growing grapes, by areas, 1928

Area	Vineyards	Fertility costs		Man labor spent in fertility practices	
		Total per acre	Percentage of total cost of growing grapes (excluding picking and marketing)	Total per acre	Percentage of total labor for growing grapes (excluding picking and marketing)
	Number	Dollars	Percent	Hours	Percent
Arkansas (1929)	78	3.19	5.3	1.9	2.4
Michigan	92	5.18	8.8	1.6	3.4
Finger Lakes, N.Y.	113	5.69	8.0	2.5	3.1
Niagara Co., N.Y.	20	7.87	11.3	2.2	4.1
Chautauqua Co., N.Y.	114	8.47	11.3	2.6	4.3
North East, Pa.	75	12.90	16.0	2.3	4.4
Hudson Valley, N.Y.	35	14.05	10.6	4.0	3.2
Girard, Pa.	26	15.75	17.9	2.5	4.4
All areas	553	8.01	11.1	2.3	3.6

In 10 of the 11 areas the return per hour of labor spent on grapes was higher for vineyards having a fertility expense below average than it was for those vineyards having a fertility expense above average. (table 33.) On the average, it cost more to produce a ton of grapes in those vineyards where more than the average amount was spent for fertility. The average of all areas showed that an increase of $20.39 per acre in total production costs (including picking and marketing) was associated with an increase in yield of only 0.17 of a ton. Under such conditions, grapes would have to sell for over $100 per ton for the increased yield to pay for the increase in production costs.

Table 32. - Average cost per acre for seeding cover crops and applying manure and fertilizer, by areas, 1928

Area	Man labor	Horse work	Motor truck	Other equipment	Materials	Interest on costs	Total cost
	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars	Dollars
Arkansas (1929)	0.53	0.32	0.03	0.09	2.13	0.09	3.19
Michigan	.69	.54	.02	.25	3.50	.18	5.18
Finger Lakes, N.Y.	1.10	.65	.01	.28	3.48	.17	5.69
Niagara Co., N.Y.	.94	.61	.01	.53	5.55	.23	7.87
Chautauqua Co., N.Y.	1.31	.78	.02	.32	5.79	.25	8.47
North East, Pa.	1.11	.77	.03	.38	10.23	.38	12.90
Hudson Valley, N.Y.	2.09	.72	.12	.26	10.45	.41	14.05
Girard, Pa.	1.13	.50	.01	.38	13.27	.46	15.75
Average	1.03	.64	.02	.29	5.79	.24	8.01

The cost of manure, cover crops, and commercial fertilizer applied during the year was all charged to the year's cost of growing grapes. This method was used since, in the case of most of those studied, each vineyard received about the same fertility treatment each year during a period of 5 years. Of those reporting for 5 years, 59 percent of the growers either used fertilizer on their vineyards every year or did not use it at all during the 5-year period, 71 percent either seeded their vineyards to a cover crop every year or not at all, and 72 percent either applied manure every year or not at all. The fertility practice in a given year tends to be the one usually followed on that farm.

Most growers who spent more than the average of the community for fertility also did more spraying, pruning, tillage, etc. This relationship was true for 10 of the 11 areas listed in table 33. An increase of $10.59 per acre in fertility costs was on an average accompanied by an increase of $7.63 per acre in other growing costs.

It is easy to spend. Success, however, depends upon getting back more than is spent. Some growers are not spending enough for fertility but many growers are spending more for fertility on their vineyards than the increase in yields is worth. Since some vineyards respond more readily than others to fertilizers, only a careful study of the behavior of vines under different conditions will enable a grower to supply his vineyard with plant food in the most economical way.

TILLAGE PRACTICES AND COSTS

Tillage is universally practiced by grape growers. During the year of this study, only 3 of the 548 growers interviewed did not till all of their vineyards. When a vineyard is not tilled it is practically abandoned.

Table 33. - Relation of the current cost of soil fertility per acre of vineyard to grape yields, costs, and returns, by areas, 1928

Area and soil	Fertility expense reported as below or above the average of the community	Vineyards	Grape yields per acre	Growing cost per acre of grapes (excluding picking and marketing): Soil fertility	Growing cost per acre of grapes (excluding picking and marketing): Other	Production cost per ton of grapes: Growing	Production cost per ton of grapes: Growing, picking & marketing	Value of land per acre 1/	Return per hour of labor
		Number	Tons	Dollars	Dollars	Dollars	Dollars	Dollars	Cents
Michigan									
Sandy soils	Below	23	1.42	2.19	46.88	34.63	47.64	69	20
" "	Above	20	1.79	7.64	53.90	34.29	48.72	64	19
Loam soils	Below	25	2.07	3.31	55.40	28.42	40.03	86	26
" "	Above	24	2.37	10.93	63.85	31.55	44.53	103	18
Girard, Pa.	Below	11	2.19	9.25	72.78	37.51	49.56	230	34
" "	Above	11	2.55	21.68	71.28	36.39	46.46	223	37
North East, Pa.									
Hill soils	Below	6	1.39	2.99	46.72	35.72	49.90	80	18
" "	Above	14	1.67	14.30	58.89	43.89	58.56	110	15
Lake plain soils	Below	29	2.28	9.66	70.70	35.19	48.05	281	22
" " "	Above	26	2.16	20.10	74.35	43.79	56.95	241	1
Chautauqua Co., N.Y.									
Lake plain soils	Below	40	1.60	4.23	63.89	42.54	54.75	151	9
" " "	Above	44	1.80	14.54	71.31	47.69	61.80	152	5
Hill soils	Below	16	1.29	2.56	61.98	50.14	64.10	84	3
" "	Above	13	1.45	13.32	63.47	53.00	66.62	130	-5
Hudson Valley, N.Y.	Below	17	2.29	6.14	101.91	47.15	63.16	224	32
" " " "	Above	18	2.66	24.44	138.85	61.40	79.87	356	16
Arkansas (1929)	Below	48	1.38	0.68	55.06	40.36	57.34	106	13
" "	Above	30	1.45	5.81	58.87	44.50	58.32	100	10
Finger Lakes, N.Y.	Below	54	1.45	1.85	63.76	45.19	60.02	86	21
" " " "	Above	59	1.61	10.03	66.54	47.50	60.34	75	20
Niagara Co., N.Y.	Below	10	2.12	0.36	60.98	28.95	41.86	88	76
" " " "	Above	10	1.83	16.97	62.63	43.56	58.40	92	35
All areas									
Average of averages									
	Below	25	1.77	3.93	63.64	38.71	52.40	135	25
	Above	24	1.94	14.52	71.27	44.32	58.32	150	16

1/ Vines and trellis not included.

Cost of Tilling Vineyards

For the vineyards studied, the average cost of tillage amounted to about one fifth of the total cost of growing grapes, picking and marketing not included. The ratio of tillage costs to total growing costs varied in the different areas from an average of 27 percent in the Niagara Co., N.Y., and Finger Lakes, N.Y., areas to 14 percent in the Girard, Pa., and Arkansas areas.

An average of 17.6 hours of man labor were spent in tillage work which was 28 percent of the total labor used in growing grapes, picking and marketing not included. (table 34.) The equivalent of one horse for 18.5 hours of horse work and one tractor for 2.2 hours of tractor work were used per acre of vineyard to draw tillage tools. This tillage work amounted to over 60 percent of the total horse hours and to 92 percent of the tractor hours used in growing grapes. Tillage work with tractor power was greatest in Pennsylvania, and in Niagara Co., and Chautauqua Co., N.Y.

Table 34. - Average amount of man labor and power used in tilling an acre of vineyard, by areas, 1928

Area	Man labor	Horse work	Tractor work	Percentage that tillage hours were of total hours used in growing grapes 1/		
				Man	Horse	Tractor
	Hours	Hours	Hours	Percent	Percent	Percent
Girard, Pa.	11.2	7.8	3.4	19.8	51.3	81.1
Michigan	12.6	14.8	0.4	26.3	59.3	89.5
North East, Pa.	15.2	12.6	4.5	29.3	56.3	93.8
Arkansas (1929)	15.7	17.0	1.1	19.4	51.5	87.1
Niagara Co., N.Y.	16.4	12.2	3.9	31.2	53.3	98.4
Chautauqua Co.,N.Y.	18.9	22.9	2.9	30.8	65.8	94.5
Finger Lakes, N.Y.	22.8	24.6	1.6	28.6	75.4	92.4
Hudson Valley, N.Y.2/	45.9	36.4	1.0	35.8	74.1	88.7
Average	17.6	18.5	2.2	27.9	63.3	92.5

1/ Harvesting and marketing not included.
2/ The man labor and power charged to crops interplanted in vineyard are not included. The vineyard's share of man labor and power here reported represented 68.6 percent of the total amount of man labor and power.

The average cost of tilling vineyards was about $15 per acre and varied in the different areas from an average of $8.67 in Arkansas to $36.15 in the Hudson Valley. (table 35.)

In most of the areas, the cost of man labor amounted to approximately one half and the cost of horse and tractor work to about one third of the total tillage cost. For all areas, the average cost of using horse- and tractor-drawn tillage tools amounted to $1.97 per acre, which was equal to 38 percent of the combined cost of horse and tractor work.

Table 35. - Cost of tilling an acre of vineyard, by areas, 1928

Area	Man labor	Horse work	Tractor work	Tillage tools 1/	Interest	Total	Percentage that tillage costs were of total cost of growing grapes 2/
	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Percent
Arkansas (1929)	4.03	2.65	1.14	.68	0.17	8.67	14.4
Michigan	5.33	3.01	.37	1.25	.35	10.31	17.5
Girard, Pa.	5.44	1.77	3.10	1.90	.36	12.57	14.2
North East, Pa.	7.16	2.91	2.63	2.43	.46	15.59	19.3
Chautauqua Co., N.Y.	9.35	4.23	2.01	2.36	.54	18.49	24.7
Finger Lakes, N.Y.	10.18	4.90	.95	2.23	.55	18.81	26.6
Niagara Co., N.Y.	8.75	2.27	2.89	4.35	.54	18.80	27.0
Hudson Valley, N.Y. 3/	22.12	9.17	.63	3.18	1.05	36.15	27.4
Average	7.89	3.69	1.49	1.97	.45	15.49	21.4

1/ Includes a small miscellaneous cost for the following areas: Michigan, 1 cent; Girard, Pa., 2 cents; North East, Pa., 5 cents; Finger Lakes, N.Y., 3 cents

2/ Harvesting and marketing not included.

3/ Costs charged to crops interplanted in vineyard are not included. The vineyard's share represented 68.6 percent of the total tillage cost.

There was a wide variation among the areas in the kind of power used in tillage work. Of the total hours of man labor used in tillage work, over one half in Arkansas and 90 percent in the Hudson Valley represented time spent with implements drawn by one horse or one mule. (table 36.) In the Chautauqua-Erie area, about one fifth of the man labor spent in tilling vineyards represented work with one horse. Practically all of the work with one horse in this area was "horse hoeing."

Table 36. - Proportionate amount of man labor spent in tillage work with indicated number of horses and tractor, by areas, 1928

Area	1 horse	2 horses	More than 2 horses	Tractor	Total
	Percent	Percent	Percent	Percent	Percent
Chautauqua Co., N.Y.	13.6	66.9	0.0	19.5	100.0
North East, Pa.	22.7	40.2	0.0	37.1	100.0
Girard, Pa.	29.6	36.6	0.0	33.8	100.0
Michigan	31.0	63.8	0.6	4.6	100.0
Niagara Co., N.Y.	42.1	26.9	0.0	31.0	100.0
Finger Lakes, N.Y.	54.6	36.8	0.0	8.6	100.0
Arkansas (1929)	54.3	33.0	3.9	8.8	100.0
Hudson Valley, N.Y.	90.5	6.6	0.0	2.9	100.0
All areas	39.7	44.4	0.4	15.5	100.0

The Michigan growers interviewed used tractors very little in 1928. Most of their plowing and disking was done with 2-horse teams. Most of the Michigan vineyards were on soils that are easily worked. The custom in the Hudson Valley of interplanting currants between the rows of grape vines is the chief reason why 1 horse (rather than 2 horses or a tractor) is used for tillage work.

There was also considerable variation among the different areas in the use of different tillage tools. In the Finger Lakes area, over half of the man hours used in tilling vineyards were spent in plowing whereas in Pennsylvania only 12 percent of the tillage work was for plowing. (table 37.) The Pennsylvania growers spent a much larger proportion of their time disking and harrowing. Cultivators were used very little in vineyards, except by the growers in the Hudson Valley and Chautauqua County areas. Horse hoes were generally used in each of the areas, except Hudson Valley. Hand work, such as hoeing and mowing, was done in all the areas and varied from 16 percent of the total hours used in tillage work in the Finger Lakes area to 27 percent in Michigan.

Table 37. - Proportionate amount of man labor used in the performance of indicated tillage operations in vineyards, by areas, 1928

Area	Plowing	Harrowing, disking, etc.	Cultivating	Horse hoeing	Hand work	Total
	Percent	Percent	Percent	Percent	Percent	Percent
Girard, Pa.	11.8	48.6	0.2	19.3	20.1	100.0
North East, Pa.	12.7	41.0	2.0	24.5	19.8	100.0
Chautauqua Co., N.Y.	17.3	33.2	11.2	20.6	17.7	100.0
Michigan	25.8	29.4	0.3	17.6	26.9	100.0
Arkansas (1929)	26.5	29.8	3.8	21.7	18.2	100.0
Niagara Co., N.Y.	27.7	27.5	0.6	21.6	22.6	100.0
Hudson Valley, N.Y.	34.1	11.1	31.2	0.1	23.5	100.0
Finger Lakes, N.Y.	51.5	17.0	1.6	14.1	15.8	100.0
All areas	27.7	27.8	7.5	17.0	20.0	100.0

Dates of Beginning and Ending Tillage

A majority of the growers interviewed in Arkansas for 1929, and in the Hudson Valley and Chautauqua County areas for 1928, began tilling their vineyards in April; in the other areas the majority began in May. (table 38.) Among growers in the same area, there was a variation of from 1 to 2 months or more in the time of the first tillage operation. About one third of all vineyards studied were tilled for the first time during the first week in May, and two thirds were tilled for the first time during the last week in April or the first two weeks in May. Plowing was the initial tillage operation on about four fifths of the vineyards.

Among growers in the same area, the variation as to the time they stopped tillage work was even greater. Six growers out of ten interviewed stopped tillage during the last three weeks in July or the first week in August.

Table 38. - Number of vineyards for which the first and last tillage operations were reported during indicated week, by areas, 1928

VINEYARDS THAT WERE TILLED FOR THE FIRST TIME DURING SEASON

Area	Prior to April 1	Week of April - 1st	Week of April - 2nd	Week of April - 3rd	Week of April - 4th	Week of May - 1st	Week of May - 2nd	Week of May - 3rd	Week of May - 4th	After May 31	Total
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
Arkansas (1929)	4	2[illegible]	6	3	11	20	10	1	1	2	78
Michigan	-	1	9	4	7	27	17	8	9	10	92
Hudson Valley, N.Y.	-	2	4	7	7	13	1	-	-	-	34
Girard, Pa.	-	-	1	-	5	8	4	-	-	1	19
North East, Pa.	-	2	3	1	11	45	9	3	1	-	75
Chautauqua Co.,N.Y.	2	9	21	7	31	27	10	4	1	2	114
Niagara Co., N.Y.	-	-	-	-	4	6	5	2	2	1	20
Finger Lakes, N.Y.	-	2	10	7	13	46	18	6	5	3	110
Total	6	36	54	29	89	192	74	24	19	19	542

VINEYARDS THAT WERE TILLED FOR THE LAST TIME DURING SEASON

	Prior to June 15	Week of June - 3rd	Week of June - 4th	Week of July - 1st	Week of July - 2nd	Week of July - 3rd	Week of July - 4th	Week of August - 1st	Week of August - 2nd	After Aug. 14	Total
	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number	Number
Arkansas (1929)	9	[illegible]	5	14	10	8	8	6	2	5	74
Michigan	6	1	6	1	11	10	16	16	6	12	35
Hudson Valley, N.Y.	-	-	-	2	5	8	7	6	1	5	34
Girard, Pa.	3	1	2	2	-	2	1	2	1	1	15
North East, Pa.	-	2	1	2	3	11	26	22	5	2	74
Chautauqua Co., N.Y.	1	1	4	1	7	3	27	30	18	22	114
Niagara Co., N.Y.	3	2	3	2	4	2	1	1	-	1	19
Finger Lakes, N.Y.	4	4	8	10	21	17	14	13	6	10	107
Total	26	18	29	34	61	61	100	96	39	58	522

Plowing

For the year of the study, only 11 percent of the vineyard acreage was not plowed, and 4 percent was only partly plowed. (table 39.) The least plowing was reported by the Girard growers; an average of 31 percent of their acreage was not plowed. The Finger Lakes growers did the most plowing; 31 percent of their acreage was plowed once and 63 percent twice during the season. In the Hudson Valley 58 percent of the acreage was plowed twice. There were as many growers interviewed in Michigan who plowed their vineyards twice as there were who plowed but once during the season.

Table 39. - Importance of plowing as a vineyard tillage operation, by areas, 1928 season

Area	Percentage of vineyard acreage plowed: 1 time	2 times	3 times	Partly plowed 1/	Not plowed	Total
	VINEYARD ACREAGE PLOWED					
	Percent	Percent	Percent	Percent	Percent	Percent
Finger Lakes, N.Y.	30.7	63.2	-	5.7	0.4	100.0
Hudson Valley, N.Y.	39.8	58.0	-	-	2.2	100.0
North East, Pa.	70.6	23.3	1.2	0.0	4.9	100.0
Michigan	44.4	43.1	1.2	2.3	9.0	100.0
Chautauqua Co., N.Y.	52.3	23.9	1.8	4.7	17.3	100.0
Niagara Co., N.Y.	52.4	-	-	23.8	23.8	100.0
Arkansas (1929)	50.1	10.0	-	12.5	27.4	100.0
Girard, Pa.	53.2	10.9	-	4.7	31.2	100.0
All areas	49.8	33.6	0.9	4.3	11.4	100.0
	VINEYARDS REPRESENTED					
	Number	Number	Number	Number	Number	Number
Finger Lakes, N.Y.	30	73	-	8	1	112
Hudson Valley, N.Y.	11	23	-	-	1	35
North East, Pa.	55	16	1	-	4	76
Michigan	42	43	1	3	3	92
Chautauqua Co., N.Y.	66	21	2	6	18	113
Niagara Co., N.Y.	14	-	-	4	2	20
Arkansas (1929)	40	7	-	8	23	78
Girard, Pa.	12	3	-	2	5	22
Total	270	186	4	31	57	548

1/ Usually 2 furrows per row.

For all vineyards studied about 5 acres were gang plowed to 1 acre plowed with a single-bottom plow. The single plow was generally used by the growers in Hudson Valley and in Arkansas. In the Hudson Valley over 90 percent and in Arkansas over 70 percent of the plowed acreage was plowed with a single plow. (table 40.) In the Finger Lakes area 38 percent of the acreage plowed was done with a single plow. Interplanted fruit in the Hudson Valley, cheap labor in Arkansas, and the hillsides in the Finger Lakes area probably explain why so much of the plowing in these areas was done with the single plow.

Table 40. - Power used in plowing vineyards with gang plow and with single plow, by areas, 1928

VINEYARD ACREAGE PLOWED

Area	Percentage plowed with -					
	Gang plow		Single plow			
	Tractor	Horses	1 horse	2 horses	1 and 2 horses	Total
	Percent	Percent	Percent	Percent	Percent	Percent
North East, Pa.	57.6	42.4	-	-	-	100.0
Girard, Pa.	57.4	33.0	9.6	-	-	100.0
Chautauqua Co., N.Y.	20.0	79.7	0.3	-	-	100.0
Michigan	2.8	96.0	0.8	0.4	-	100.0
Finger Lakes, N.Y.	23.8	38.3	12.9	1.9	23.1	100.0
Niagara Co., N.Y.	37.3	24.4	-	10.2	28.1	100.0
Arkansas (1929)	26.9	2.3	37.6	6.6	26.6	100.0
Hudson Valley, N.Y.	5.1	2.0	88.6	-	4.3	100.0
All areas	25.6	57.9	9.0	1.0	6.5	100.0

VINEYARDS REPRESENTED

	Number	Number	Number	Number	Number	Number
North East, Pa.	1/ 38	34	-	-	-	72
Girard, Pa.	5	7	3	-	-	15
Chautauqua Co., N.Y.	2/ 16	72	1	-	-	89
Michigan	3	82	1	1	-	87
Finger Lakes, N.Y.	15	32	22	2	32	103
Niagara Co., N.Y.	4	3	-	3	4	14
Arkansas (1929)	2	1	21	7	16	47
Hudson Valley, N.Y.	3	1	29	-	1	34
Total	86	232	77	13	53	461

1/ Includes 4 vineyards where a small part of the acreage was plowed with horses.
2/ Includes 2 vineyards where a small part of the acreage was plowed with horses.

In Michigan, Pennsylvania, and Chautauqua County, New York, practically all of the plowing was done with gang plows. A special 3-gang vineyard plow was usually used. Eighty-two growers interviewed in Michigan did their gang plowing with horses and only 3 with tractors. (table 40.) More tractor-drawn plows were used in Chautauqua County, N.Y., than in Michigan. In Pennsylvania the acreage plowed by tractor-drawn plows exceeded that plowed by horse-drawn plows. Michigan vineyards in general were more easily tilled than Pennsylvania vineyards and hired labor cost less in Michigan than in Pennsylvania.

A vineyard was usually gang plowed by going twice to the row. In addition to the six furrows made by the gang a single plow was often used to plow a furrow next to the vines. This was the practice on 89 percent of the acreage gang plowed in the Finger Lakes areaand over half of the acreage gang plowed in Michigan. (table 41.) In Chautauqua County, N. Y., and the two Pennsylvania areas, the single plow was not commonly used to supplement the work of the gang plow.

Table 41. - Acreage gang plowed only, and acreage gang and single plowed, for areas where 200 or more acres were gang plowed, 1928

Area	Gang plowed only 1/	Gang and single plowed 2/	Gang plowed only	Gang and single plowed
	Acres	Acres	Percent	Percent
Girard, Pa.	270	0	100.0	0.0
North East, Pa.	2,224	203	91.6	8.4
Chautauqua Co., N.Y.	2,140	493	81.3	18.7
Michigan	1,595	1,743	47.8	52.2
Finger Lakes, N.Y.	160	1,332	10.7	89.3

1/ Usually, 3-bottom gang plow, twice to the row.
2/ In addition to the usual 6 furrows plowed with a 3-bottom gang, twice to the row, single furrows were plowed next to the vines.

It usually took from 3 to 4 times as long to plow an acre with a single plow going 6 to 10 times to the row as it did with a gang plow going twice to the row. Plowing with a 1-horse single plow cost $10.36 an acre for labor and power in the Hudson Valley, and $7.68 in the Finger Lakes area. (table 42.) Plowing with a 2-horse single plow in the Finger Lakes area cost $5.15 per acre.

The Arkansas growers plowed an acre with a 1-mule single plow in 3.71 hours less time than did the Finger Lakes growers with a 1-horse single plow. Because of this lower time requirement together with the lower cost of labor and horse work in the Arkansas area, plowing in Arkansas cost only about one third as much as in the Finger Lakes area. In the Finger Lakes area, vineyards on the steeper hillsides probably were plowed with 1 horse. The cost per hour of labor used in plowing with a single plow in Arkansas was only 56 percent of the cost in the Finger Lakes area, but the cost for horse work in Arkansas was 76 percent of the cost to the Finger Lakes growers. It was cheaper to plow in Arkansas at 1929 rates with a single plow drawn by 1 mule than with a single plow drawn with 2 mules.

Going twice to the row with a gang plow in the Finger Lakes area, the average cost was $2.25 per acre when drawn by 2 horses, and $2.34 per acre when drawn by tractor. Gang plowing in North East, Pa. cost $1.66 per acre with 2 horses and $1.28 per acre with a tractor. In Girard, Pa. an acre was gang plowed in less than an hour when tractors were used. Gang plowing cost less in Michigan than in the other areas. The Chautauqua growers on the average took 59 percent more time to gang plow an acre than the Michigan growers. Many of the Chautauqua vineyards were on silty clay loam soil more difficult to work than the sandy soils in Michigan.

Table 42. - Average amount and cost of labor and power per acre to plow vineyards once over with gang plow and with single plow operated by 1 man and drawn by indicated power, by areas, 1928

Kind of plow, power, and area	Equivalent to acreage covered once	Times per row	Amount per acre: Man labor	Amount per acre: Power	Cost per hour: Man labor	Cost per hour: Power	Cost per acre for man labor and power
	Acres	Number	Hours	Hours	Cents	Cents	Dollars
Gang plow, 2 horses							
Michigan	2978	2	1.48	2.96	44.6	19.7	1.23
North East, Pa.	978	2	1.85	3.70	48.3	20.7	1.66
Chautauqua Co., N.Y.	2155	2	2.35	4.70	49.9	16.3	1.94
Finger Lakes, N.Y.	886	2	2.62	5.24	41.4	22.2	2.25
Gang plow, tractor							
North East, Pa.	1290	2	1.17	1.17	51.8	58.0	1.28
Girard, Pa.	170	2	.91	.91	64.3	94.8	1.45
Finger Lakes, N.Y.	391	2	2.04	2.04	50.7	64.2	2.34
Single plow							
Arkansas (1929)							
1 mule	315	9.4	6.84	6.84	24.4	14.4	2.65
1 and 2 mules	243	7.9	5.48	9.49	27.4	17.3	3.14
Finger Lakes, N.Y.							
1 horse	414	6.6	10.55	10.55	48.3	24.5	7.68
1 and 2 horses	392	6.4	8.44	11.37	43.6	19.7	5.92
2 horses	451	6.3	6.18	12.36	46.7	18.3	5.15
Hudson Valley, N.Y.							
1 horse	472	8.1	14.11	14.11	50.6	22.8	10.36
Single plow							
Arkansas (1929)							
1 mule	558	2	1.46	1.46	26.9	16.0	.63
North East, Pa.							
1 horse	231	2	1.81	1.81	39.8	21.2	1.11
Chautauqua Co., N.Y.							
1 horse	479	2	2.52	2.52	49.7	20.9	1.78
2 horses	200	2	2.19	4.38	52.4	20.3	2.02
Finger Lakes, N.Y.							
1 horse	899	2	3.14	3.14	43.3	18.6	1.94
2 horses	292	2	2.48	4.96	39.0	23.8	2.15
Michigan							
1 horse	1122	2	1.54	1.54	43.0	19.7	.97
2 horses	557	2	1.25	2.50	45.3	17.9	1.01

The cost of plowing was nearly doubled on those farms where the single plow was used in addition to the gang. Most of the Chautauqua County and Pennsylvania growers did not use the single plow. To avoid using it, some growers did not use the single plow. To avoid using it, some growers added an extra plow to the gang. Growers who gang plowed with tractors did less single plowing than did those who gang plowed with horses.

Of the vineyards studied in Arkansas, 31 were not plowed and 47 were plowed, in 1929. The tillage costs averaged $2.64 more per acre on the plowed vineyards. (table 43.) Usually tillage operations, that take the place of plowing, cost less than plowing and there was no evidence in the records taken that the vineyards that were plowed the most yielded better than the others.

Table 43. - Relation of the amount of plowing to grape yields and costs, by areas, 1928

Area and number of times plowed	Vineyards	Times plowed	Grape yields per acre	Growing cost per acre: Tillage	Growing cost per acre: Other growing cost 1/	Total growing cost per ton 1/
	Number	Number	Tons	Dollars	Dollars	Dollars
Arkansas (1929)						
Not plowed	31	0.0	1.46	7.06	50.18	39.21
Plowed	47	1.2	1.39	9.70	52.33	44.59
Michigan						
Plowed once or less	48	0.8	1.84	9.89	47.77	31.34
Plowed twice or more	44	2.0	1.86	10.83	49.73	32.56
Girard, Pa.						
Not plowed	7	0.0	2.64	13.05	82.06	36.03
Plowed	15	1.2	2.27	12.30	72.32	37.28
North East, Pa.						
Plowed once or less	59	0.9	2.07	15.41	62.88	37.82
Plowed twice or more	17	2.1	2.03	16.02	55.69	35.33
Chautauqua Co., N.Y.						
Not plowed	24	0.0	1.73	15.16	58.71	42.70
Plowed	89	1.3	1.61	19.23	54.39	45.73
Finger Lakes, N.Y.						
Plowed once or less	39	0.8	1.71	18.44	49.27	39.60
Plowed twice	73	2.0	1.43	19.19	51.56	49.48
Niagara Co., N.Y.						
Not plowed	6	0.0	1.91	14.69	46.39	31.98
Plowed once	14	1.0	2.04	21.75	53.93	37.10
Hudson Valley, N.Y.						
Plowed once or less	12	0.9	2.10	32.93	99.75	63.18
Plowed twice	23	2.0	2.70	38.48	92.93	48.67
Average of averages:						
Vineyards plowed less:	28	0.4	1.93	15.83	62.13	49.39
Vineyards plowed more:	40	1.6	1.92	18.44	60.35	41.04

1/ "Growing Costs" include all costs up to picking.

Disking, Harrowing, and Cultivating

The disk and harrow were used more by the Pennsylvania vineyardists than by those in other States. From 3 to 4 times as many hours were spent in the Pennsylvania vineyards in disking and harrowing as were used in plowing. The time spent in disking and harrowing also exceeded the time spent in plowing the vineyards studied in Chautauqua Co., N. Y., Michigan, and Arkansas. Growers in the Finger Lakes and Hudson Valley areas made the least use of the disk and harrow. In the Finger Lakes vineyards, 3 hours were spent in plowing to each hour spent in disking and harrowing.

In terms of acreage covered once, the disk was used more than twice as much as the harrow in the Girard and Arkansas vineyards, and nearly twice as much in the Chautauqua vineyards. (table 44.) In Michigan, however, the harrow was used nearly twice as much as the disk. According to Dr. Partridge, cultivation should be shallow in grape vineyards and for this type of cultivation the harrow is a better tool than the disk on light soils and the disk is more effective on loams. Possibly this difference in the adaptation of the two tools has some influence in determining the greater use of the harrow in Michigan vineyards.

Table 44. - Use made of the disk, harrow, cultivator, and roller in tilling vineyards, by areas, 1928

Area	Percentage of total work measured in terms of acreage covered once					Acreage covered once
	Disk	Harrow	Cultivator	Roller, planker, etc.	Total	
	Percent	Percent	Percent	Percent	Percent	Acres
Girard, Pa.	67.6	31.8	0.2	0.4	100.0	2,560
Arkansas (1929)	66.6	25.7	5.9	1.8	100.0	4,255
Niagara Co., N.Y.	54.4	40.3	2.4	2.9	100.0	664
North East, Pa.	53.9	41.8	4.3	0.0	100.0	9,298
Chautauqua Co., N.Y.	50.5	27.5	20.0	2.0	100.0	11,243
Michigan	36.3	62.2	1.5	0.0	100.0	7,361
Finger Lakes, N.Y.	28.6	67.6	3.6	0.2	100.0	4,418
Hudson Valley, N.Y.	3.0	37.2	59.8	0.0	100.0	2,156
All areas	46.8	41.7	10.7	0.8	100.0	41,955

For the vineyards studied, the disk is used primarily as a tractor-drawn tool and the harrow primarily as a horse-drawn tool. For all vineyards, 77.4 percent of the acreage harrowed was harrowed with horses, and 70.6 percent of the acreage disked was disked with tractors. (table 45.) Both a disk and harrow were sometimes hitched in combination behind a tractor.

Table 45. - Power used to disk, harrow, and cultivate, as measured by percentage of total vineyard acreage covered once, by areas, 1928

Area	1 horse	2 horses	More than 2 horses	Tractor	Total	Equivalent to acreage covered once
	Percent	Percent	Percent	Percent	Percent	Acres
DISK						
Hudson Valley, N.Y.	-	-	-	100.0	100.0	64
Niagara Co., N.Y.	-	4.5	-	95.5	100.0	361
Girard, Pa.	-	16.4	-	83.6	100.0	1,732
Chautauqua Co., N.Y.	1.1	17.0	-	81.9	100.0	5,675
North East, Pa.	0.2	14.0	-	85.8	100.0	7,005
Finger Lakes, N.Y.	-	26.7	-	73.3	100.0	1,263
Arkansas (1929)	-	36.4	10.0	53.6	100.0	2,833
Michigan	-	65.2	1.5	33.3	100.0	2,676
All areas	0.4	27.3	1.7	70.6	100.0	21,609
HARROW						
Hudson Valley, N.Y.	33.4	55.2	-	11.4	100.0	803
Niagara Co., N.Y.	-	13.8	-	86.2	100.0	267
Girard, Pa.	3.1	76.2	-	20.7	100.0	814
Chautauqua Co., N.Y.	3.9	83.9	-	12.2	100.0	3,090
North East, Pa.	0.5	53.9	-	45.6	100.0	3,886
Finger Lakes, N.Y.	11.9	64.9	-	23.2	100.0	2,984
Arkansas (1929)	2.3	76.3	7.7	13.7	100.0	1,095
Michigan	1.7	83.5	4.3	10.5	100.0	4,576
All areas	5.1	70.7	1.6	22.6	100.0	17,515
CULTIVATE						
Hudson Valley, N.Y.	100.0	-	-	-	100.0	1,289
Chautauqua Co., N.Y.	6.8	93.2	-	-	100.0	2,252

In Michigan and Arkansas the common practice was to make one trip to the row when harrowing or disking with a tractor but two trips with horses. Considerable saving in time results if the harrow or disk can be so adjusted that one trip with the tractor does as satisfactory work as two trips with horses. (table 46.) The practice of going once to the row with the tractor-drawn disk or harrow was not so generally followed by the North East, Pa., growers as by the Michigan and Arkansas growers, and was practiced less by the Chautauqua producers than by the North East, Pa., growers. Differences in soil texture and ease with which the soil is tilled, may explain the differences in this practice.

Table 46. - Percentage of acreage covered 1/ by making one, two, and more trips to the row with tractor- and horse-drawn disks and harrows by areas, 1928

DISK

Area	Tractor-drawn				Horse-drawn			
	Times to row				Times to row			
	1	2	More than 2	Total	1	2	More than 2	Total
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Michigan	85.4	14.6	-	100.0	11.6	78.1	10.3	100.0
Girard, Pa.	80.9	18.2	0.9	100.0	52.5	47.5	-	100.0
Arkansas (1929)	67.3	32.7	-	100.0	3.0	74.1	22.9	100.0
North East, Pa.	22.9	77.1	-	100.0	7.3	92.7	-	100.0
Finger Lakes, N.Y.	23.4	73.9	2.7	100.0	42.6	57.4	-	100.0
Chautauqua Co., N.Y.	9.4	90.6	-	100.0	-	99.4	0.6	100.0
Hudson Valley, N.Y.	-	100.0	-	100.0	-	-	-	-
Niagara Co., N.Y.	-	100.0	-	100.0	-	100.0	-	100.0
All areas	31.5	68.3	.2	100.0	10.5	81.0	8.5	100.0

HARROW

Michigan	81.6	18.4	-	100.0	15.2	84.5	0.3	100.0
Girard, Pa.	35.8	64.2	-	100.0	86.3	13.7	-	100.0
Arkansas (1929)	-	100.0	-	100.0	9.6	77.3	13.1	100.0
North East, Pa.	34.8	65.2	-	100.0	15.0	85.0	-	100.0
Finger Lakes, N.Y.	0.7	99.3	-	100.0	30.5	65.0	4.5	100.0
Chautauqua Co., N.Y.	17.2	82.8	-	100.0	11.0	88.9	0.1	100.0
Hudson Valley, N.Y.	49.2	50.8	-	100.0	-	98.3	1.7	100.0
Niagara Co., N.Y.	33.8	66.2	-	100.0	-	100.0	-	100.0
All areas	31.8	68.2	-	100.0	19.0	79.1	1.9	100.0

1/ In terms of acreage covered once.

The average time required to disk an acre twice to the row with a tractor-drawn disk was 1.25 hours in Chautauqua Co., N.Y., 1.09 hours in North East, Pa., and 0.98 of an hour in Arkansas. The cost varied from $1.49 per acre in Chautauqua County to $1.11 per acre in Arkansas. (table 47.) It required 0.63 of an hour more in Arkansas to 0.92 of an hour more in North East, Pa., and 1.03 hours more in Chautauqua Co., N.Y., to disk an acre with horse-drawn than with tractor-drawn disks. In Chautauqua County and North East, Pa., the cost of disking an acre twice to the row was more with horse-drawn than with tractor-drawn disks, but in Arkansas the cost was less with horse-drawn than with tractor-drawn disks.

In the Hudson Valley vineyards, almost 3 hours were spent cultivating to 1 hour disking and harrowing. These growers used 1-horse cultivators and more often went 4 times to the row than 2 times to the row. An average of 6.3 hours were required to cultivate an acre 4 times to the row at a cost for labor and power of $5.01 per acre. The cost at 2 times to the row averaged $2.29

Table 47. - Cost per acre to till vineyards once over, with disk, harrow and cultivator, with indicated power, by areas, 1928

Area	Equivalent to acres covered once	Times per row	Time per acre per crew	Cost per hour: Man labor	Cost per hour: Power	Cost per acre for man labor and power
	Acres	Number	Hours	Cents	Cents	Dollars
DISK DRAWN BY TRACTOR						
Arkansas (1929)	1023	1	.45	22.9	110.8	.60
Michigan	581	1	.58	43.8	64.6	.63
North East, Pa.	1374	1	.61	52.5	72.9	.76
Girard, Pa.	1171	1	.56	59.3	87.9	.82
Chautauqua Co., N.Y.	372	1	.98	46.0	72.3	1.16
Arkansas (1929)	497	2	.98	28.9	84.3	1.11
North East, Pa.	4532	2	1.09	52.1	56.2	1.18
Finger Lakes, N.Y.	682	2	1.04	47.6	66.1	1.18
Niagara Co., N.Y.	345	2	1.08	64.8	72.1	1.48
Chautauqua Co., N.Y.	4051	2	1.25	51.1	68.2	1.49
DISK DRAWN BY 2 HORSES						
Arkansas (1929)	737	2	1.61	28.8	17.3	1.02
Michigan	1393	2	1.39	44.2	21.6	1.21
North East, Pa.	882	2	2.01	42.4	19.4	1.63
Chautauqua Co., N.Y.	777	2	2.28	45.0	20.0	1.94
HARROW DRAWN BY 2 HORSES						
Michigan	380	1	0.90	49.3	16.4	.74
Girard, Pa.	557	1	1.06	38.5	27.4	.99
North East, Pa.	317	1	1.03	38.2	26.6	.94
Finger Lakes, N.Y.	596	1	1.37	41.0	18.0	1.05
Chautauqua Co., N.Y.	282	1	1.30	53.1	17.3	1.14
Arkansas (1929)	648	2	1.54	23.7	15.5	.84
Michigan	3430	2	1.42	43.6	19.7	1.18
North East, Pa.	1770	2	1.72	45.2	21.1	1.50
Finger Lakes, N.Y.	1275	2	1.96	42.1	18.4	1.55
Chautauqua Co., N.Y.	2307	2	2.12	49.5	16.3	1.74
HARROW DRAWN BY TRACTOR						
Finger Lakes, N.Y.	688	2	0.99	41.7	50.8	.92
North East, Pa.	1124	2	.93	52.9	55.5	1.01
CULTIVATOR DRAWN BY 2 HORSES						
North East, Pa.	359	2	1.67	48.6	20.3	1.49
Chautauqua Co., N.Y.	2098	2	2.24	51.4	20.2	2.05
CULTIVATOR DRAWN BY 1 HORSE						
Chautauqua Co., N.Y.	154	2	2.62	61.2	22.6	2.20
Hudson Valley, N.Y.	466	2	3.87	38.4	20.8	2.29
Hudson Valley, N. Y.	652	4	6.31	57.1	22.3	5.01

per acre, which was twice as much as it cost Pennsylvania growers to disk an acre of vineyard twice to the row with tractor-drawn disks.

In the Chautauqua vineyards one third as much time was spent cultivating as disking and harrowing. Two-horse cultivators were generally used, twice to the row. On the average, it required 2.2 hours to cultivate an acre with 2-horse cultivators twice to the row at a cost for labor and power of $2.05 per acre, which was about the same as the cost for disking twice to the row with horse-drawn disks. Although it is cheaper to control weeds by disking and harrowing than by cultivating, the wider tools cannot be used in the Hudson Valley vineyards where currants are interplanted.

In table 48, comparisons are made among 7 groups of vineyards that were disked, harrowed, and cultivated a "greater" and a "less" number of times. In every case vineyards that received the greater amount of harrowing, disking, and cultivating, produced the higher yields. The growing cost per ton of grapes for those vineyards disked and harrowed the greater number of times averaged $1.05 less than the cost for the vineyards that received less tillage. The cost per ton for those vineyards where the greater amount of plowing was done was $0.65 higher than the cost for those vineyards where less plowing was done. When it can be done, it is more economical to control weeds with the disk and harrow than with the plow or horse hoe.

Table 48. - Comparison of the number of times vineyards were disked, harrowed, or cultivated during the season with grape yields and costs, by areas, 1928

Area	Times that vineyards were disked, harrowed, or cultivated	Vineyards	Growing cost per acre of grapes (excluding picking and marketing)		Grape yields per acre	Growing cost per ton of grapes (excluding picking and marketing)
			Tillage	Other		
	Number	Number	Dollars	Dollars	Tons	Dollars
Arkansas (1929)	3 or less	37	7.72	51.70	1.27	46.79
	4 or more	41	9.89	51.15	1.55	39.38
Michigan						
Fox, Bellefontaine soils	3 or less	35	10.36	52.58	2.15	29.27
	4 or more	14	10.22	55.45	2.18	30.12
Coloma, Plainfield soils	2 or less	23	9.50	45.05	1.51	36.13
	3 or more	20	9.85	44.99	1.60	32.45
North East, Pa.						
Light-textured soils	5 or less	24	14.56	68.95	2.11	39.58
	6 or more	21	15.59	74.18	2.46	36.49
Heavy-textured soils	4 or less	11	12.00	45.24	1.68	35.78
	5 or more	20	19.20	54.59	1.65	44.72
Chautauqua Co., N.Y.	5 or less	79	16.49	55.71	1.58	45.70
	6 or more	34	23.44	57.56	1.74	46.55
Finger Lakes, N.Y.						
Fulteney, Bluff Point, Naples	1 or less	44	20.24	55.08	1.41	53.42
	2 or more	32	19.06	54.17	1.56	46.94
Average of averages	Less	36	12.98	53.47	1.66	40.03
	More	26	15.32	56.01	1.83	38.98

Horse Hoeing

Grape horse hoes were commonly used in all areas except in the Hudson Valley. The hoe, or blade, stirs the soil close to the vines and under the wire, the blade being guided around the trunk of the vine, by manipulating the left handle.

The Girard and Finger Lakes growers usually horse hoed their vineyards once during the season. (table 49.) In North East, Pa., and Chautauqua County, N.Y., it was almost as common to horse hoe the vineyards twice during the season as once. In 1929, eight of the Arkansas growers interviewed, horse hoed their vineyards 3 times and 2 vineyards were horse hoed 4 times. (table 50. In Chautauqua County, on 72 percent of the acreage horse hoed, the hoe was drawn by 2 horses. In all other areas the horse hoe was usually drawn by one horse. (table 51.) As yet this tool has not been adapted to tractor use.

Table 49. - Proportion of vineyard acreage horse hoed during season, by areas, 1928

Area	Average number of times acreage was horse hoed	Percentage of acreage: Not horse hoed	Horse hoed once	Horse hoed twice	Horse hoed more than twice	Total acreage
	Number	Percent	Percent	Percent	Percent	Acres
Arkansas (1929)	1.7	5.7	48.6	19.8	25.9	1,062
North East, Pa.	1.4	2.2	53.8	44.0	-	2,026
Chautauqua Co., N.Y.	1.3	9.5	46.3	44.2	-	2,409
Michigan	1.4	3.2	58.2	38.6	-	2,491
Niagara Co., N.Y.	1.1	8.1	74.7	17.2	-	194
Girard, Pa.	1.0	1.6	92.2	6.2	-	405
Finger Lakes, N.Y.	0.9	13.7	85.2	1.1	-	1,739
Hudson Valley, N.Y.	1/	98.8	1.2	-	-	360
All areas	1.3	9.6	57.8	30.0	2.6	10,686

1/ Less than 0.1

Table 50. - Number of vineyards that were horse hoed the indicated number of times during season, by areas, 1928

Area	Vineyards horse hoed indicated number of times: 0	1	2	3	4	Total vineyards
	Number	Number	Number	Number	Number	Number
Arkansas (1929)	7	43	18	8	2	78
North East, Pa.	2	43	30	-	-	75
Chautauqua Co., N.Y.	14	49	51	1	-	114
Michigan	2	53	37	-	-	92
Niagara Co., N.Y.	2	15	3	-	-	20
Girard, Pa.	3	18	1	-	-	22
Finger Lakes, N.Y.	16	95	1	-	-	112
Hudson Valley, N.Y.	34	1	-	-	-	35
All areas	80	317	140	9	2	548

Table 51. - For vineyards horse hoed, the percentage of acreage horse hoed by indicated crew, by areas, 1928

Area	1 man - 1 horse	1 man - 2 horses	1 or 2 men with tractor
	Percent	Percent	Percent
Hudson Valley, N. Y.	100.0	-	-
Finger Lakes, N. Y.	99.3	-	0.7
Arkansas (1929)	99.1	0.9	-
Girard, Pa.	98.0	2.0	-
Michigan	87.1	12.9	-
Niagara Co., N. Y.	85.7	14.3	-
North East, Pa.	64.1	33.2	2.7
Chautauqua Co., N. Y.	25.0	72.4	2.6
All areas	70.5	28.2	1.3

The average time required to horse hoe an acre twice to the row, for the first horse hoeing of the season, varied from about 1.7 hours per acre in Michigan to 3.7 hours in the Finger Lakes area. (table 52.) It usually takes longer to horse hoe than to gang plow an acre.

Table 52. - Average amount of time required to horse hoe an acre of vineyard twice to the row, by areas, 1928

Area	Amount of time to horse hoe one acre	
	Initial horse hoeing	Subsequent horse hoeing
	Hours	Hours
Michigan	1.66	1.54
Arkansas (1929)	1.88	1.62
Girard, Pa.	2.17	1/
Niagara Co., N. Y.	2.82	1/
North East, Pa.	2.72	2.37
Chautauqua Co., N. Y.	3.27	2.22
Finger Lakes, N. Y.	3.69	1/

1/ Data not available.

When working the soil away from the row, greater care is required to guide the hoe so as not to injure or tear out vines than when working the soil toward the row. The soil is usually worked away from the vines in the first horse hoeing of the season, and toward the vines in the second horse hoeing. On an average, the initial horse hoeing of the season took about one fifth more time than the other horse hoeings.

The average cost of horse hoeing with one-horse hoes amounted to $0.67 per acre in Arkansas and $1.03 per acre in Michigan. In all other areas the cost was considerably higher, averaging well above $2.00 per acre, except in the Girard, Pa., area where the average cost was$1.63 per acre. (table 53.)

Table 53. - Cost per acre of horse hoeing vineyards twice to the row, with indicated crews, by areas, 1928

Area	Cost per hour - Man labor	Cost per hour - Horse work	Cost per acre for labor and horse work
	1 MAN 1 HORSE		
	Cents	Cents	Dollars
Arkansas (1929)	24.5	14.2	0.67
Michigan	44.6	21.7	1.03
Girard, Pa.	49.7	26.0	1.63
North East, Pa.	48.3	28.5	2.14
Niagara Co., N.Y.	56.9	15.8	2.28
Finger Lakes, N.Y.	45.6	19.0	2.38
Chautauqua Co., N.Y.	49.2	22.3	2.40
	1 MAN 2 HORSES		
Michigan	40.4	18.6	1.57
North East, Pa.	47.4	25.4	2.24
Chautauqua Co., N.Y.	50.9	18.1	2.46

Hand Hoeing

In the Hudson Valley an average of about 10 hours per acre of vineyard were spent in hand hoeing, which was about 3 times that reported in any other area. (table 54.) In all areas, there were 112 vineyards, or about 1 in 5, for which no hand hoeing was reported. (table 55.) Five hours or less per acre of hand hoeing were reported on 72 percent of the vineyards that were hand hoed.

The average expense per acre for hand hoeing for all vineyards studied in an area, including vineyards not hand hoed, varied from $4.03 in the Hudson Valley to $0.60 in Arkansas. (table 54.) A majority of the hours of hand hoeing in each area was done by hired labor.

Tillage costs increased as the amount of hand hoeing increased. This was true for all but one of the 12 comparisons in table 56. An average of the averages for Arkansas, Pennsylvania, Chautauqua Co., N.Y., and Michigan showed an increase in tillage cost of 23 percent for vineyards hand hoed 3 or more hours per acre compared with those hand hoed less than 3 hours per acre. A comparison of horse hoeing for these same 4 areas showed an increase in tillage cost of only 5 percent for vineyards horse hoed more than once during the season compared with those horse hoed once or less.

An average of the averages for Arkansas, Pennsylvania, Chautauqua Co., N.Y., and Michigan showed that the growing cost per ton of grapes was $5.70 more for those vineyards horse hoed and hand hoed the greatest number of times compared with those vineyards horse hoed and hand hoed the least number of times. Hand hoeing is especially expensive, and, along with other tillage operations, may be done more cheaply if the work is done early in the season.

Table 54. - Average cost of hand hoeing per acre for all vineyards studied, and proportion of hand hoeing done by indicated persons, by areas, 1928 1/

Area	Hand hoeing per acre			Proportion of total hours of hand hoeing done by -		
	Amount	Cost per hour	Cost per acre	Operator	Other unpaid labor	Hired labor
	Hours	Cents	Dollars	Percent	Percent	Percent
Hudson Valley, N.Y.	10.2	39.5	4.03	17.7	6.9	75.4
Niagara Co., N.Y.	3.7	41.2	1.52	28.9	13.8	57.3
Finger Lakes, N.Y.	3.5	42.8	1.50	34.4	10.2	55.4
Chautauqua Co., N.Y.	3.0	41.3	1.24	24.6	11.8	63.6
Michigan	3.2	38.2	1.22	36.8	10.8	52.4
North East, Pa.	3.0	39.6	1.19	17.2	13.1	69.7
Girard, Pa.	2.4	39.9	.96	15.1	3.2	81.7
Arkansas (1929)	2.6	22.9	.60	21.7	21.4	56.9
All areas	3.3	38.9	1.28	26.3	11.4	62.3

1/ Averages are for total acreage studied, whether hand hoed or not.

Table 55. - Number of vineyards on which the indicated number of hours per acre of hand hoeing were spent during season, by areas, 1928

Area	Vineyards hand hoed						
	0.0 hours	0.1 to 2.5 hours	2.6 to 5.0 hours	5.1 to 7.5 hours	7.6 to 10.0 hours	More than 10 hours	Total vineyards
	Number	Number	Number	Number	Number	Number	Number
Hudson Valley, N.Y.	1	1	4	2	5	22	35
Niagara Co., N.Y.	8	1	6	2	1	2	20
Finger Lakes, N.Y.	25	27	38	9	7	6	112
Michigan	3	37	37	7	5	3	92
North East, Pa.	8	22	38	5	1	1	75
Chautauqua Co., N.Y.	38	11	30	18	6	2	114
Arkansas (1929)	23	13	23	7	6	6	78
Girard, Pa.	6	8	6	0	1	1	22
All areas	112	120	191	50	32	43	548

Table 56. - Relation of horse hoeing and hand hoeing to grape yields and costs, by areas, 1928

Area	VINEYARDS			
	Vineyards horse hoed once or less during season		Vineyards horse hoed more than once during season	
	Quantity of hand hoeing per acre			
	Less than 3 hours	3 hours or more	Less than 3 hours	3 hours or more
	Number	Number	Number	Number
Arkansas (1929)	25	25	14	14
Pennsylvania	39	27	14	17
Chautauqua Co., N.Y.	32	31	23	28
Michigan	29	26	21	16
Niagara Co., N.Y.	7	10	2	1
Finger Lakes, N.Y.	54	57	1	0
Hudson Valley, N.Y.	3	32	0	0
Total	189	208	75	76
	TILLAGE COST PER ACRE			
	Dollars	Dollars	Dollars	Dollars
Arkansas (1929)	8.23	11.12	6.56	12.25
Pennsylvania	12.94	17.14	16.28	16.35
Chautauqua Co., N.Y.	15.77	19.34	17.09	22.23
Michigan	9.96	10.94	10.45	9.87
Average of averages	11.72	14.64	12.60	15.18
Niagara Co., N.Y.	15.24	17.53	22.54	33.47
Finger Lakes, N.Y.	16.73	21.33	17.35	-
Hudson Valley, N.Y.	25.77	36.99	-	-
	GROWING COST PER TON OF GRAPES 1/			
	Dollars	Dollars	Dollars	Dollars
Arkansas (1929)	38.31	41.15	46.38	46.34
Pennsylvania	35.26	41.93	37.48	44.68
Chautauqua Co., N.Y.	43.09	46.44	44.17	51.27
Michigan	31.22	34.66	33.20	28.40
Average of averages	36.97	41.04	40.31	42.67
Niagara Co., N.Y.	41.65	30.52	32.18	53.00
Finger Lakes, N.Y.	41.06	52.26	62.23	-
Hudson Valley, N.Y.	43.40	51.76	-	-
	YIELD OF GRAPES PER ACRE			
	Tons	Tons	Tons	Tons
Arkansas (1929)	1.49	1.46	1.34	1.37
Pennsylvania	2.23	2.04	2.33	1.82
Chautauqua Co., N.Y.	1.62	1.62	1.66	1.59
Michigan	1.86	1.67	1.83	2.12
Average of averages	1.80	1.70	1.79	1.72
Niagara Co., N.Y.	1.52	2.36	2.22	1.42
Finger Lakes, N.Y.	1.63	1.42	1.72	-
Hudson Valley, N.Y.	2.11	2.48	-	-

1/ Does not include cost of picking and marketing.

Size of Farm and Tillage Costs

The farms studied in Chautauqua Co., N.Y., and Erie County, Pa., were grouped by size, according to the acreage in crops. (table 57.) Crop acreage included that in fruit, cultivated crops, grain, hay, and other crops, grown on owned and rented land. Acreages used for pasture, woods, roads, and farmstead were not included.

Table 57. - Relation of size of farm to tillage costs per acre of vineyard, Chautauqua Co., N.Y., and Erie County, Pa., 1928

Size of farm (Crop acreage)				Difference in tillage	
Range	Average	Acreage in vineyard	Tillage cost per acre of vineyard	cost from one acreage group to the next	Vineyards
Acres	Acres	Acres	Dollars	Dollars	Number
Less than 25	15	10	22.82	-	51
25 to 49	36	18	18.13	4.69	81
50 to 74	62	29	16.50	1.63	46
75 and more	111	45	14.34	2.16	33

Fifty one of the vineyards studied in Chautuaqua Co., N.Y., and Erie Co., Pa., were on farms of less than 25 crop acres, averaging 15 acres, of which 10 acres were in grapes. The average cost of tilling vineyards on these small farms was high, averaging $22.82 per acre. This cost was 59 percent greater than the average cost to till an acre of vineyard on farms of 75 or more crop acres.

The group of farmers working 36 crop acres, on the average, tilled their vineyards for $4.69 less per acre than did the group working an average of 15 crop acres, a difference in tillage costs of one fifth. For the group averaging 62 crop acres, the tillage cost per acre of vineyard was only $1.63 less than the cost for the group with 36 crop acres. But tillage costs on the farms with an acreage of 62 crop acres were $2.16 more per acre of grapes than the cost on the farms with 111 crop acres.

In each of the areas studied tillage costs per acre of vineyard averaged less on the larger farms than on the smaller farms. (table 58.) Savings in tillage costs on farms of 50 or more crop acres compared with farms of less than 50 crop acres varied in the different areas from an average of 15 percent in North East, Pa., to 41 percent in the Hudson Valley.

Growers on the larger farms used only about 70 percent as much labor to till an acre of vineyard as did growers on the smaller farms. Tractors were more generally used on the larger farms. On the smaller farms, much of the tillage work was done with one horse. On the smaller farms in the Finger Lakes area, work with one horse amounted to 57 percent of the total labor used in tilling vineyards compared with only 35 percent on the larger farms.

Table 58. - Relation of size of farm to tillage costs per acre of vineyard, by areas, 1928

Area	Tillage cost per acre of vineyard for farms with crop acreage of -		Difference in tillage costs between large and small farms	Vineyards on farms with crop acreage of -	
	Less than 50 acres	50 acres and more		Less than 50 acres	50 acres and more
	Dollars	Dollars	Dollars	Number	Number
Arkansas (1929)	10.21	7.97	2.24	36	42
Michigan	11.33	9.57	1.76	53	39
Girard, Pa.	15.76	11.01	4.75	19	8
North East, Pa.	17.24	14.62	2.62	44	31
Chautauqua Co., N.Y.	21.60	16.05	5.55	73	41
Finger Lakes, N.Y.	21.59	16.77	4.82	68	45
Niagara Co., N.Y.	26.95	17.45	9.50	5	15
Hudson Valley, N.Y.	40.34	23.66	16.68	30	5
All areas (average of averages)	20.63	14.64	5.99	41	28

Less time is spent turning around if the rows are long. Labor, horses, and tractors were more fully employed on the larger farms and therefore the costs per hour of use were less. (table 59.) Cost rates per hour of work were less on the larger farms than on the smaller farms by 20 percent for tractor work, 9 percent for horse work, and 4 percent for man labor. The lower cost rates and the saving in time in tilling an acre on the larger farms resulted in lower tillage costs on the larger farms by $5.99 per acre, or 29 percent. Costs other than for tillage averaged less on the larger farms than on the smaller farms in 7 of the 8 areas. The average difference for the 8 areas was $4.41 per acre, or 7 percent.

On the average, grape yields in 5 of the 8 areas were somewhat higher on the larger farms than on the smaller farms, even though costs were lower on the larger farms. (table 60.) For all areas, grapes were grown on the larger farms for $6.54, or 14 percent, less per ton than on the smaller farms.

Operators of small farms who did not own or hire a tractor usually kept 2 horses; but of those owning a tractor, about as many kept 1 horse as kept 2 horses. On the larger farms where tractors were owned the number of horses per farm averaged 2.5. There was over twice as much horse and tractor work on the larger farms as on the smaller farms, and, on the average, a horse was used during the year, 42 percent more hours on the larger than on the smaller farms and a tractor was used 121 percent more hours on the larger farms. The combined yearly cost per crop acre of horse and tractor work and of man labor, including the value of the operator's time, was 24 percent larger on the smaller horse-operated farms than on the larger horse-operated farms, and 35 percent larger on the smaller farms having tractors than on the larger farms with tractors.

On the smaller farms, the cost of using a tractor, including depreciation and interest, averaged only $140 for the year 1928, which was less than the average cost of keeping one horse for a year. On the larger farms, because of the additional work, the year's cost of operating a tractor was $282, but the average cost per hour was 9 percent less on the larger farms than on the smaller farms.

Table 59. - Average quantity per acre and cost per hour of man labor, horse work, and tractor work, used in tilling vineyards on small farms and on large farms, by areas, 1928

Area	Quantity of tillage work per acre of vineyard on farms of -		Cost per hour for labor and power used in tilling vineyards on farms of -	
	Less than 50 crop acres	50 crop acres and more	Less than 50 crop acres	50 crop acres and more
	Hours	Hours	Cents	Cents
MAN LABOR				
Arkansas (1929)	18.8	14.3	26.7	25.0
Michigan	13.9	11.7	42.4	42.4
Girard, Pa.	14.9	8.7	44.8	52.5
North East, Pa.	16.8	14.3	45.5	48.2
Chautauqua Co., N.Y.	20.7	17.5	53.5	45.9
Finger Lakes, N.Y.	25.8	20.6	47.7	41.8
Niagara Co., N.Y.	17.5	16.2	51.3	53.7
Hudson Valley, N.Y.	50.1	27.9	50.1	38.4
Average of averages	22.3	16.4	45.2	43.5
HORSE WORK				
Arkansas (1929)	21.6	14.9	16.1	15.2
Michigan	15.8	14.0	21.3	19.7
Girard, Pa.	17.3	2.5	26.9	23.5
North East, Pa.	17.8	9.5	22.0	24.3
Chautauqua Co., N.Y.	26.9	19.8	21.1	15.8
Finger Lakes, N.Y.	28.1	22.0	21.7	18.3
Niagara Co., N.Y.	11.9	12.2	26.1	17.5
Hudson Valley, N.Y.	40.5	22.6	25.5	29.5
Average of averages	22.5	14.7	22.6	20.5
TRACTOR WORK				
Arkansas (1929)	0.7	1.3	102.6	99.2
Michigan	0.3	0.5	125.7	74.9
Girard, Pa.	2.0	4.2	92.9	89.3
North East, Pa.	3.1	5.3	75.5	52.6
Chautauqua Co., N.Y.	2.4	3.4	69.0	57.9
Finger Lakes, N.Y.	0.4	2.4	93.9	56.4
Niagara Co., N.Y.	4.6	3.8	83.3	71.4
Hudson Valley, N.Y.	1.2	2.0	60.9	52.8
Average of averages	1.8	2.9	88.0	70.6

Table 60. - Grape yields and costs for small and large farms, by areas, 1928

Area	Yield of grapes per acre on farms with -		Growing cost per acre of grapes (excluding tillage cost) on farms with-		Growing cost per ton of grapes (excluding picking and marketing) on farms with-	
	Less than 50 crop acres	50 crop acres and more	Less than 50 crop acres	50 crop acres and more	Less than 50 crop acres	50 crop acres and more
	Tons	Tons	Dollars	Dollars	Dollars	Dollars
Arkansas (1929)	1.18	1.52	49.41	52.40	50.53	39.72
Michigan	1.83	1.87	49.69	47.93	33.34	30.75
Girard, Pa.	2.04	2.42	75.53	73.26	44.75	34.82
North East, Pa.	2.26	1.95	67.05	63.96	37.30	40.30
Chautauqua Co.,N.Y.	1.78	1.50	60.59	52.77	46.17	45.88
Finger Lakes, N.Y.	1.46	1.58	54.95	49.77	52.42	42.11
Niagara Co., N.Y.	2.08	1.97	57.62	49.64	40.66	34.06
Hudson Valley,N.Y.	2.40	2.60	98.38	88.15	57.80	43.00
All areas (average of averages)	1.88	1.93	64.15	59.74	45.37	38.83

On the smaller farms not using tractors, 57 hours of horse work were used per acre of vineyard; but on smaller farms using tractors, 30 hours of horse work and 6 hours of tractor work were used per acre. According to this relationship 1 hour of tractor work in the vineyard replaced more than 4 hours of horse work. On the average, it was slightly more economical to work farms of less than 50 crop acres without tractors. On the smaller farms with tractors the cost for all power and labor averaged $1.47 more per crop acre than on farms without tractors.

Of the 79 growers who worked 50 or more acres of crop land only 14 did not own a tractor. On the average, these 14 growers in 1928 did not work their farms as economically as did those who owned tractors. The cost per crop acre for all power and labor was $2.97 less on the larger farms where tractors were used than on the larger farms where tractors were not used.

Quantity of Tillage Labor, Grape Yields, and Costs

The small farms, or those of less than 50 crop acres, were divided into 2 equal groups, according to the labor spent per acre in tillage work. Tillage for one group averaged 25.8 hours per acre, and for the other group, 14.1 hours per acre, a difference of 11.7 hours, or 45 percent. (table 62.) Tillage costs averaged $20.39 per acre for the 25.8-hour group and $13.21 for the 14.1-hour group. A similar comparison is shown in table 62 for the larger farms.

There was no tendency for vineyard yields to be higher in those groups where the most labor was used in tilling vineyards. Since the yields were about the same, probably weeds were about as well controlled in the group using less labor as in the group using more labor.

It is probably not so much a question of hours worked as effectiveness of work. The smaller the weed plant the less it costs to kill it. Timeliness in tillage operations is important as well as using to the maximum degree, those tillage tools that are most effective and economical in killing weeds. Those tools seem to be the harrow and disk.

Use of Tractors and Horses, Chautauqua-Erie Farms

A majority of the growers interviewed in Chautauqua Co., N.Y., and Erie Co., Pa., who worked less than 50 crop acres did not use tractors. Four fifths of the growers working 50 crop acres or more used tractors.(table 61.)

Table 61. - Power costs on small and large farms, with and without tractors, Chautauqua-Erie vineyards, 1928

Item		Farms of less than 50 crop acres		Farms of 50 crop acres or more	
		No tractor	Tractor	No tractor	Tractor
Farms	number 1/	67	50	14	65
Crop acreage per farm:					
Vineyard	acres	15	17	38	36
Other crops	do	13	15	27	50
Total	do	28	32	65	86
Grape yields per acre	tons	2.0	1.9	1.7	1.8
Horse work:					
Horses per farm	number	1.9	1.4	3.0	2.5
Horse work per farm per year:					
Vineyard	hours	855	504	1,753	987
Other work	do	506	342	888	1,156
Total	do	1,361	846	2,641	2,143
Work per horse per year	hours	716	604	880	857
Cost per horse per year	dollars	155	149	158	174
Cost per hour of horse work	cents	21.6	24.7	18.0	20.3
Tractor work:					
Tractors per farm	number	-	1.00	-	1.05
Tractor work per farm per year:					
Vineyard	hours	-	107	-	196
Other work	do	-	102	-	266
Total	do	-	209	-	462
Cost per hour of tractor work	cents	-	66.9	-	61.0
Power and labor costs per farm:					
Horse work	dollars	291	204	475	438
Tractor work	do	-	140	-	282
Labor	do	1,354	1,583	2,610	3,106
Total	do	1,645	1,927	3,085	3,826
Cost per crop acre	do	58.75	60.22	47.46	44.49
Operator's earnings	dollars	220	33	-850	-426

1/ Does not include farms on which tractors were hired.

Table 62. - Comparison of the quantity of labor used in tilling vineyards, cost of growing grapes, and yields, for small farms and for large farms, by areas, 1928 1/

VINEYARDS

Area	Small farms (less than 50 crop acres)		Large farms (50 crop acres and more)	
	More tillage	Less tillage	More tillage	Less tillage
	Number	Number	Number	Number
Michigan	26	27	19	20
Arkansas (1929)	18	18	21	21
Pennsylvania	29	30	19	19
Chautauqua Co., N.Y.	35	36	21	21
Finger Lakes, N.Y.	33	34	23	22
Total	141	145	103	103

LABOR PER ACRE USED IN TILLING VINEYARDS

	Hours	Hours	Hours	Hours
Michigan	18.4	10.5	14.8	9.7
Arkansas (1929)	25.0	13.6	24.4	9.5
Pennsylvania	20.4	12.2	17.2	10.0
Chautauqua Co., N.Y.	28.4	15.0	21.4	12.6
Finger Lakes, N.Y.	36.7	19.2	25.1	16.6
Average of averages	25.8	14.1	20.6	11.7

TILLAGE COST PER ACRE

	Dollars	Dollars	Dollars	Dollars
Michigan	13.67	9.58	11.96	8.08
Arkansas (1929)	13.83	7.14	11.80	6.11
Pennsylvania	19.19	14.17	16.63	11.79
Chautauqua Co., N.Y.	28.31	16.66	18.31	13.27
Finger Lakes, N.Y.	26.95	18.51	19.18	14.64
Average of averages	20.39	13.21	15.58	10.78

GROWING COST PER TON OF GRAPES 2/

	Dollars	Dollars	Dollars	Dollars
Michigan	37.20	30.76	32.57	29.59
Arkansas (1929)	53.50	47.36	37.16	41.10
Pennsylvania	38.48	37.20	45.28	34.39
Chautauqua Co., N.Y.	54.08	40.34	45.72	46.01
Finger Lakes, N.Y.	54.87	50.60	42.09	42.18
Average of averages	47.63	41.25	40.56	38.65

YIELD OF GRAPES PER ACRE

	Tons	Tons	Tons	Tons
Michigan	1.71	1.92	1.90	1.85
Arkansas (1929)	1.25	1.13	1.71	1.43
Pennsylvania	2.35	2.17	1.83	2.22
Chautauqua Co., N.Y.	1.76	1.81	1.57	1.42
Finger Lakes, N.Y.	1.51	1.43	1.65	1.52
Average of averages	1.72	1.69	1.73	1.69

1/ Vineyards were sorted into equal groups according to the hours of labor used per acre in tillage operations on small farms and on large farms.

2/ Does not include cost of picking and marketing.

SPRAYING AND DUSTING

Practices and Results

Black rot is the most destructive fungous disease of the grape. 6/ It spreads rapidly in rainy hot weather. The climate in Arkansas is especially favorable for the spread of black rot, and damage from this disease was unusually severe in Arkansas in 1929. Excessive rains during May and June interfered with spraying. All but one of the vineyards studied in Arkansas were sprayed in 1929, and black rot ruined the crop on this 10-acre vineyard. A grower caring for 60 acres of vineyard sprayed 40 acres just before the bloom but did not spray the other 20 until 2 weeks later. No grapes were harvested from these 20 acres because of black rot. Crops from several vineyards were so badly damaged by black rot, that after the diseased berries were shaken off, less than half the crop remained and could be sold for juice purposes only.

The University of Arkansas, in 1927, recommended that 4 sprays be made for black rot. The first spray was to be applied just before the bloom; the second spray, immediately after the bloom; the third spray, two weeks after the second; and the fourth spray, 2 weeks after the third. 7/

One fifth of the vineyard acreage studied in Arkansas was sprayed either 4 or 5 times in 1929. (table 63.) Two sprays during the season were more commonly applied than either 4 or 5. Forty-five percent of the acreage was sprayed 3 times and 28 percent was sprayed twice. Because of dry weather during the last half of July and August the last spray was not so necessary as it would have been if rainy weather had prevailed.

On the average, the Arkansas vineyards that received a relatively large number of sprays produced more grapes than did those receiving fewer sprays, and the return per hour of labor averaged more for the vineyards that were sprayed 3 or more times than for the vineyards sprayed 2 times or less. (table 64.) The Arkansas vineyards receiving a large number of sprays were not cared for more intensively than the other vineyards as indicated by "other growing costs" per acre. Timeliness, as well as the proper number, is absolutely essential to the control by spraying of black rot and other diseases and insects. However, the data collected did not permit a comparison of the effects of timeliness in spraying on yields and returns.

About one half of the vineyard acreage studied in Michigan was sprayed and about one third was dusted. A larger proportion of the vineyard acreage was dusted in Michigan than in the other areas; 20 of the Michigan growers interviewed depended entirely upon dust and 3 Michigan growers applied both dust and spray. However, Dutton 8/ found by experiments at Paw Paw, Michigan, that dusting for black rot control was less effective than spraying.

6/ Quaintance, A. L. and Shear, C. L. Insect and Fungous Enemies of the Grape. U. S. Department of Agriculture, Farmers' Bulletin No. 1220, 1921. Revised 1926.

7/ University of Arkansas, Extension Circular 143, 1927.

8/ Dutton, W. C. Grape dusting experiments, 1923. Annual report of the Michigan State Horticultural Society, p. 154.

Table 63. - Proportion of vineyard acreage sprayed and dusted, by areas, 1928

Area	Percentage of vineyard acreage sprayed the indicated number of times					Percentage of vineyard acreage			
	1	2	3	4	5	Dusted	Dusted and sprayed	Neither sprayed nor dusted	Total
	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent	Percent
Niagara Co., N.Y.	11.0							89.0	100.0
Chautauqua Co., N.Y.	23.4	0.2	0.1			3.2		73.1	100.0
Finger Lakes, N.Y.	26.4	8.4	0.5			5.0		59.7	100.0
Hudson Valley, N.Y.	46.0	13.1	0.2			13.9		26.8	100.0
North East,Pa.	42.9	10.0	3.7			18.5		24.9	100.0
Michigan	8.5	19.5	17.1	3.3		32.3	3.7	15.6	100.0
Girard, Pa.	12.4	61.6	4.0	1.1		10.1		10.8	100.0
Arkansas (1929)	5.0	27.9	45.2	17.2	3.4			1.3	100.0
All areas	22.4	13.4	9.5	2.5	0.3	13.5	0.8	37.6	100.0

About one third of the Michigan vineyards studied were sprayed or dusted twice, and one third, three times, during the season. Vineyards sprayed 3 or more times produced more than did vineyards sprayed less than 3 times, but on the average, the vineyards sprayed the greatest number of times were also cared for more intensively in other ways. In 1928, the average return per hour of labor spent on these more intensively cared-for vineyards was about the same as the return for labor spent on the less intensively cared-for vineyards.

Only 26.9 percent of the vineyard acreage studied in Chautauqua County was sprayed or dusted in 1928. The sprayed vineyards yielded about the same as the vineyards that were not sprayed. Probably the vineyards in the Chautauqua-Erie belt are protected from black rot by Lake Erie. The lake tends to moderate the summer temperature and to keep the air constantly moving; this dries the foliage quickly after a rain. A majority of the North East growers interviewed applied one spray in 1928.

The extent of diseases and insects, as well as the effectiveness of spraying, varies from year to year depending somewhat upon weather conditions. Sprays may be considered as efficient weapons with which to reduce or eliminate

Table 64. - Relation of spraying and dusting of vineyards to yields, costs, and returns, averages by areas and soil type, 1928

Area and number of sprays or dusts	Applications	Cost per acre: Spray or dust	Cost per acre: Other growing costs	Grape yields per acre	Growing cost per ton of grapes	Return per hour of labor	Acreage per vineyard	Vineyards
	Number	Dollars	Dollars	Tons	Dollars	Cents	Acres	Number
Girard, Pa.								
No spray or dust	0.0	0.00	73	0.90	81	-29	5	5
1 spray 1/	1.3	5.92	77	2.03	41	21	16	4
2 sprays	2.0	9.89	81	2.59	35	44	17	15
North East, Pa. (Lake Plain)								
No spray or dust	0.0	0.00	76	2.03	37	6	19	13
1 spray 1/	1.1	5.65	81	2.28	38	17	29	30
2 sprays 1/	2.3	12.02	82	2.23	42	7	30	7
Dust	1.6	5.64	85	2.25	40	5	41	5
Chautauqua Co., N.Y. (Lake Plain)								
No spray or dust	0.0	.07	72	1.66	43	8	22	56
Spray	0.9	6.03	76	1.69	48	- 1	27	23
Dust	0.8	4.74	75	1.93	41	0	19	5
Chautauqua Co., N.Y. and North East, Pa.(Hill vineyards)								
No spray or dust	0.0	0.00	64	1.42	45	4	17	33
Spray	0.8	5.18	76	1.59	51	- 4	19	10
Hudson Valley, N.Y.								
No spray or dust	0.0	.05	121	2.26	53	36	9	9
Spray	1.2	10.20	128	2.42	57	15	12	19
Dust	1.6	4.47	117	2.93	42	46	7	7

- Continued -

Table 64. - Relation of spraying and dusting of vineyards to yields, costs, and returns, averages by areas, and soil type, 1928 - Continued

Area and number of sprays or dusts	Applications	Cost per acre: Spray or dust	Cost per acre: Other growing costs	Grape yields per acre	Growing cost per ton of grapes	Return per hour of labor	Acreage per vineyard	Vineyards
Finger Lakes, N.Y.	Number	Dollars	Dollars	Tons	Dollars	Cents	Acres	Number
Pulteney, Naples								
No spray or dust	0.0	.01	72	1.19	61	22	12	19
Spray	1.2	2.93	73	1.53	50	18	19	14
Bluff Point								
No spray or dust	0.0	.07	77	1.57	49	10	12	32
Spray	0.7	2.49	69	1.42	50	8	24	8
Hector								
No spray or dust	0.0	0.00	67	1.35	49	26	13	11
Spray	0.9	3.40	55	1.10	53	13	22	9
Seneca								
No spray or dust	0.0	.24	69	2.59	27	29	9	10
Spray	1.2	3.48	62	2.07	32	51	55	2
Dust	1.8	3.08	63	1.86	36	20	17	4
Michigan								
Fox, Bellefontaine								
Less than 2 sprays	1.0	5.18	54	1.66	36	14	18	10
2 sprays 1/	2.2	7.98	54	2.22	28	22	17	11
3 sprays 1/	3.2	14.60	62	2.43	31	14	16	16
Dust	2.8	7.06	53	2.10	29	18	37	10
Dust and spray	2.0	6.08	53	2.42	24	34	74	2
Plainfield, Coloma								
No spray	0.0	.99	45	1.23	38	14	38	9
1 or 2 sprays	1.8	5.20	52	1.62	36	17	25	15
3 sprays 1/	3.3	10.80	56	2.02	33	16	29	9
Dust	1.7	4.39	47	1.59	32	30	37	10
Arkansas (1929)								
Less than 2 sprays	0.8	3.28	46	.72	69	- 5	9	5
2 sprays 1/	2.2	10.51	45	1.39	40	7	14	24
3 sprays	3.0	16.89	44	1.50	41	14	14	30
4 or more sprays	4.2	16.92	50	1.61	42	8	10	16

1/Includes some vineyards where a small part of the acreage was sprayed more than the number of times indicated.

damage from diseases and insects. Some growers consider an unsprayed vineyard as unnecessary a risk as an uninsured building. Available information for Chautauqua-Erie vineyards for 5 years indicates that whether the sprayed vineyards yielded better than those not sprayed depended upon the season. In 1927 and again in 1928, there was not much difference in yield between sprayed and unsprayed vineyards but in 1925 the sprayed (or dusted) vineyards yielded about one fifth more than neighboring vineyards not sprayed (or dusted). (table 65.) For the 5-year period, 1924-1928, the average yields were 9 percent higher on the sprayed or dusted vineyards than on the vineyards that were not sprayed or dusted.

Table 65. - Comparison of relative yields in vineyards not sprayed or dusted with yields in vineyards sprayed or dusted, Chautauqua-Erie area, 1924-1928

Year	Vineyards: Not sprayed or dusted	Vineyards: Sprayed or dusted	Percentage of average yield, for vineyards - Not sprayed or dusted	Percentage of average yield, for vineyards - Sprayed or dusted	Increase in yield in vineyards sprayed
	Number	Number	Percent	Percent	Percent
1924	41	47	92	106	+ 14
1925	55	54	90	110	+ 20
1926	73	71	95	104	+ 9
1927	95	71	101	98	- 3
1928	104	103	98	102	+ 4
Average	-	-	95	104	+ 9

In the Finger Lakes area a majority of the interviewed growers did not spray or dust their vineyards in 1928. Dr. Reddick 9/, writing in 1918 points out that about 1908, and even earlier, the grape grower of Keuka Lake area was very proficient in the preparation of Bordeaux mixture and in the operation of a spraying machine, but that since about 1910 black rot had practically disappeared from these vineyards. Downy mildew is common in the Finger Lakes area.

The sprayed vineyards studied about Pulteney and Naples yielded better in 1928 than the unsprayed vineyards. The few vineyards that were sprayed in the other Finger Lakes areas did not yield so well, on the average, as the vineyards that were not sprayed.

Differences in climate largely explain why a majority of the vineyard acreage in Arkansas was sprayed 3 or more times during the season whereas in the Finger Lakes area a majority of the vineyard acreage was neither sprayed nor dusted. Climatic conditions are more favorable for grape diseases in the Hudson Valley than in the Chautauqua-Erie belt or in the Finger Lakes area. About three fourths of the vineyard acreage studied in the Hudson Valley was sprayed or dusted in 1928.

9/ Reddick, Donald, Grape Spraying for Lake Keuka. Yates County Farm Bureau News, June 1918.

Kinds of Spray Material Used

Black rot, mildew, and other fungous diseases are controlled with Bordeaux mixture. Bordeaux was generally prepared on the farm where used. An average of 9.3 pounds of lime and an average of 8.2 pounds of copper sulphate were added to 100 gallons of water. On the average, the cost of the lime and copper sulphate used to make 100 gallons of spray was 72 cents. (table 66.)

Table 66. - Quantity and cost of spray material used per 100 gallons of spray, all areas, 1928 1/

Kind	Quantity used in 100 gallons	Price per unit	Cash cost of materials per 100 gallons of spray
	Pounds	Cents	Dollars
Bordeaux (home made)			
Lime	9.3	1.0	.09
Copper sulphate	8.2	7.7	.63
Total	17.5	-	.72
Bordeaux (ready mixed)	16.0	12.8	2.05
Arsenate of lead	3.2	17.1	.55
Copper acetate	2.1	41.2	.87
	(Pints)		
Nicotine sulphate	0.75	147.0	1.10

1/ Arkansas, 1929.

For the last spray of the season some of the Arkansas growers used acetate of copper instead of Bordeaux. (table 67.) On ripening fruit, Bordeaux leaves a covering of spray which is objectionable.

Table 67. - Proportion of each kind of spray material used, by areas, 1928

Area	Percentage of total gallons		Percentage of total gallons to which were added		
	Bordeaux	Other	Nicotine sulphate	Arsenate of lead	Soap and other spreaders
	Percent	Percent	Percent	Percent	Percent
Chautauqua Co., N.Y.	100.0	-	10.4	96.9	15.1
Niagara Co., N.Y.	100.0	-	-	-	-
Finger Lakes, N.Y.	100.0	-	6.4	22.8	-
Hudson Valley, N.Y.	98.6	1/ 1.4	39.1	20.7	-
North East, Pa.	95.6	2/ 4.4	35.7	96.2	45.9
Girard, Pa.	92.1	3/ 7.9	48.4	93.2	22.7
Michigan	98.0	4/ 2.0	17.4	87.7	56.8
Arkansas, 1929	89.9	5/10.1	-	50.7	60.3
All areas	94.4	5.6	14.7	70.4	46.7

1/ Pyrox.
2/ Arsenate reported applied alone.
3/ Arsenate and nicotine sulphate.
4/ Nicotine sulphate and copper carbonate.
5/ Copper acetate.

Insects like berry moths, flea beetles, and grape rootworm beetles, are controlled by adding a poison to the spray, such as arsenate of lead. About 3 pounds of the powder were added to 100 gallons of spray at a cost of about 55 cents. An arsenical poison was generally added to the Bordeaux spray in the Chautauqua-Erie grape belt and in Michigan. It was used in about half the quantity of spray material applied in Arkansas.

Soap is added to increase the spreading and adhesive qualities of the spray as well as a contact insecticide and was used in over one half the spray material applied in the Michigan and Arkansas vineyards.

Nicotine is principally used for the control of the grape-leaf hopper. An average of three fourths of a pint of nicotine sulphate was added to 100 gallons of spray at a cost of $1.10. No nicotine was used on grapes by the growers interviewed in Arkansas. Nicotine was used in almost half the spray material applied to the Girard vineyards.

Time of Spraying or Dusting

About 60 percent of the spraying in the New York and Pennsylvania vineyards was done in July, and about twice as much in the first half as in the last half of July. (table 68.)

Table 68. - Number of vineyards for which spraying or dusting was reported during indicated week, 1928

Month	Week of month	New York	Pennsylvania	Michigan	Arkansas (1929)
		Number	Number	Number	Number
March	3rd				1
April	1st				6
	2nd				5
	3rd				2
	4th	2			25
May	1st				27
	2nd			1	23
	3rd	2		2	26
	4th	2		2	17
June	1st	9	8	28	25
	2nd	7	5	36	23
	3rd	10		29	10
	4th	8	6	19	14
July	1st	20	25	26	9
	2nd	33	11	18	6
	3rd	14	14	12	1
	4th	10	5	5	
August	1st	5	7	7	1
	2nd	4	2	4	
	3rd	1	2		
	4th		1		
September	-		2	1	
Total 1/	-	97	49	81	72

1/ Includes all vineyards for which the week and month of each application of spray or dust were reported.

Table 69. - Spraying costs per acre per application, by areas, and dusting costs per acre per application, 1928

SPRAYING COSTS

Area	Man labor		Power	Machinery			Materials	Interest	Total
				Sprayer or duster		Other			
	Hours	Dollars	Dollars	Hours	Dollars	Dollars	Dollars	Dollars	Dollars
Finger Lakes, N.Y.	2.5	1.08	.41	1.2	.72	.16	.54	.09	3.00
Michigan	1.8	.76	.46	1.1	1.01	.18	1.26	.13	3.80
Niagara Co., N.Y.	1.9	1.32	.28	0.9	.90	.14	1.28	.14	4.06
Girard, Pa.	1.5	.79	.64	0.8	1.21	1/ .23	1.78	.14	4.79
Arkansas (1929)	6.0	1.40	.59	1.9	1.00	.12	1.63	.10	4.84
North East, Pa.	2.2	1.08	.60	1.2	1.19	2/ .29	2.03	.15	5.34
Chautauqua Co., N.Y.	3.4	1.64	.80	1.7	1.74	.28	2.32	.20	6.98
Hudson Valley, N.Y.	7.5	3.47	.95	2.6	1.23	.42	2.45	.25	8.77
All vineyards	3.4	1.16	.56	1.4	1.07	1/ .20	1.56	.13	4.68

DUSTING COSTS

All vineyards 3/	0.4	.23	.17	.04	.59	.07	1.71	.09	2.86

1/ Includes 1 cent for other costs.
2/ Includes 2 cents for other costs.
3/ Costs on 27 vineyards dusted. Does not include vineyards dusted with hired duster.

Most of the spraying in Michigan in 1928 occurred from June 1 to the middle of July, more vineyards being sprayed in June than in July.

In Arkansas the amount of spraying continued at about the same rate from the last week in April to the second week in June. Twenty-six Arkansas vineyards were sprayed only once or twice during the season; 18 of these vineyards were sprayed before the bloom, or not later than the middle of May, and 8 were not sprayed until after the bloom, or until after the middle of May. The vineyards sprayed before the bloom period produced, on the average, about twice as many grapes as did those sprayed for the first time during the season after the bloom. In 1929 in Arkansas, it was important to apply the first spray before the bloom.

Spraying and Dusting Costs

The cost of spraying an acre once varied from an average of $3 in the Finger Lakes area to $8.77 in the Hudson Valley area, the average for all areas being $4.68. (table 69.) Usually about one third of the cost was for spray materials. Only $0.54 worth of spray material was applied per acre for one spraying in the Finger Lakes areas compared with an average of over $2 per acre for vineyards studied at North East, Pa., and in Chautauqua County and the Hudson Valley.

The cost for the use of the sprayer in applying one spray averaged over $1 per acre. The labor cost was usually more than $1 per acre for applying one spray, and the power to haul the sprayer cost an average of$0.56 per acre.

Forty-three of the growers interviewed hired sprayers and 12 hired dusters. (table 70.) The total cost of spraying an acre of vineyard once was less, on the average, with hired than with owned machines. (table 71.) Most farmers who hired sprayers had a small acreage of vineyard and orchard. Hiring a sprayer is sometimes a cheap way of getting a small vineyard and orchard sprayed. However, timeliness is sometimes of prime importance and if the sprayer cannot be hired when needed most, dependence on hiring a sprayer may prove very costly. Some growers reduce the expense of spraying by owning a sprayer in partnership with a neighbor.

Ten Arkansas growers used, in 1929, hand-pump outfits to spray their vineyards. These usually included a barrel with a capacity of 50 gallons. On the average, Arkansas growers with hand-pump outfits applied about half as much spray per acre of vineyard as was applied when power outfits were used. No doubt the foliage was better covered with spray when applied with high-pressure power outfits.

The hand-pump sprayers were much cheaper to maintain, but more labor was used in spraying an acre with hand pump than with power sprayers. The total cost of applying one spray per acre was only 51 cents less with hand pumps than with power sprayers.

Table 70. - Number of sprayers and dusters of indicated kind on farms studied, by areas, 1928 1/

Area	Sprayers used in vineyards: Owned: Power	Sprayers used in vineyards: Owned: Traction	Sprayers used in vineyards: Owned: Hand	Sprayers used in vineyards: Hired for vineyard use	Sprayers on farm but not used in vineyard	Dusters used in vineyards: Owned: Power	Dusters used in vineyards: Owned: Hand	Dusters used in vineyards: Hired for vineyard use	Dusters on farm but not used in vineyards
	Number	Number	Number	Number	Number	Number	Number	Number	Number
Niagara Co.,N.Y.	2				3				
Chautauqua Co.,N.Y.	23	2		2	22	4			1
Finger Lakes,N.Y.	13	14	1	5	23	1	3		5
Hudson Valley,N.Y.	19		2		7		6		2
Pennsylvania	51	1		11	9	6		6	1
Michigan	47	1	2	12	8	16	1	6	4
Arkansas (1929)	67	-	10	13	1				
Total	222	18	15	43	73	27	10	12	13

1/ Some sprayers and dusters were owned jointly by 2 growers. Each share of a sprayer or duster reported in the study was counted as one machine, except where records were obtained from both owners of the machine.

Traction sprayers were also cheaper to operate than power sprayers. Inventory values for traction sprayers averaged but $47 per machine compared with $226 for power sprayers. (table 72.) In the Finger Lakes area an application of spray was applied with traction sprayers for 75 cents less per acre than with power sprayers, but only one half as much spray was applied per acre with the traction outfit. Most of the traction sprayers were over 20 years old and no new traction sprayer had been purchased since 1919 by the growers interviewed in the Finger Lakes area.

On the average, in Michigan in 1928, it cost about $1.20 less per acre to dust once than to spray once. Michigan growers dusted 3.7 acres in about the time required to spray one acre. One important advantage that dusters have over sprayers is that a duster will cover a vineyard in much less time than a sprayer; this probably explains why so many of the larger vineyards in Michigan were dusted. Michigan growers that reported dusters had, on the average, 37.5 acres of vineyard and 5.2 acres of orchard. Michigan growers having one sprayer or a share interest in one sprayer had an average of about 22 acres of vineyard and 7 acres of orchard.

Most of the growers interviewed having a sprayer or duster owned but 1 machine. Seven Arkansas growers had more than 1 sprayer; the average number was 3. These 7 farms had an average of 50 acres of vineyard and 76 acres of orchard, or for each sprayer an average of 16 acres of vineyard and 24 acres of orchard. (table 73.) In areas where the time of applying the vineyard spray is less exacting than in Arkansas, a much larger grape acreage is cared for per sprayer. Thus in the Chautauqua-Erie belt and in the Finger Lakes area where vineyards, if sprayed, are usually sprayed but once during the season, the farmers having one power sprayer had on the average about 30 acres of vineyard and 12 acres of orchard.

Table 71. - Comparison of spray outfits with dust outfits for machines used in vineyards in 1928, by areas

Area and kind of outfit		Vine-yards	Usual size of tank	Season's use per sprayer or duster	Machine cost per season 1/	Amount per acre per application: Spray or dust	Man labor	Total cost per acre per appli-cation	Grape yields per acre	Spray or dust applications per acre of vineyard
		Number	Gallons	Hours	Dollars	Gallons	Hours	Dollars	Tons	Number
Arkansas (1929)										
Power sprayers	hired	13	-	-	-	100	3.6	3.15	0.89	2.1
Hand pump sprayers	owned	10	50	67	11	74	7.8	4.50	1.33	2.9
Power sprayers	owned	54	200	175	90	155	6.1	5.01	1.51	3.0
Michigan										
Power sprayers	hired	12	150	-	-	99	1.8	3.49	2.04	1.8
Power sprayers	owned	41	100	87	67	91	1.6	3.72	1.92	2.4
						(Pounds)				
Power dusters	owned	15	-	42	64	18	.4	2.44	1.89	2.6
Power dusters	hired	5	-	-	-	18	1.0	2.97	1.79	1.2
						(Gallons)				
Chautauqua-Erie										
Power sprayers	hired	13	200	-	-	93	1.4	4.98	2.08	1.3
Power sprayers	owned	74	150	78	66	136	2.4	5.71	2.10	1.2
						(Pounds)				
Power dusters	hired	6	-	-	-	26	.7	3.85	1.65	1.0
Power dusters	owned	9	-	40	55	22	.7	3.89	2.03	1.7
						(Gallons)				
Finger Lakes, N.Y.										
Power sprayers	owned	12	100	65	52	71	2.1	3.32	1.54	1.0
Traction sprayers	owned	13	50	40	7	35	2.8	2.57	1.37	.9

1/ Includes annual depreciation, repairs, gas, oil, housing, and interest for sprayer or duster.

Table 72. - Machine cost of using power sprayers, power dusters, and traction sprayers, all areas, 1928 1/

Item		Power sprayers	Power dusters	Traction sprayers
Sprayers and dusters at end of year	number	217	25	18
Season's use per machine				
Vineyard	hours	53	31	32
Other	do	67	9	6
Total		120	40	38
Inventory value of machine at end of year	dollars	226	243	47
Costs per season, per machine				
Depreciation 2/	do	33	34	4
Repairs	do	12	2	1
Gas	do	7	2	-
Oil	do	2	1	-
Interest	do	15	16	3
Other 3/	do	8	6	1
Total		77	61	9
Cost of machine per hour of use	do	0.64	1.52	0.24

1/ Arkansas, 1929.

2/ Depreciation; the value of a machine at the end of the year was subtracted from itsvalue at the beginning of the year or from its cost price if bought during the year.

3/ Information was obtained from the grower concerning depreciation, repairs, gas, oil, and interest, and these costs were assumed to represent 90 percent of the total, the other 10 percent was assumed to cover the cost of housing machine and the use of farm labor in repairing and caring for machine.

Table 73. - Acreage in vineyard and orchard for indicated kind of spray and dust outfits which were used on vineyards in 1928

Area and kind of outfit		Farms	Vineyard and orchard acreage per farm			Sprayers or dusters 1/	Season's use per machine	Spray or dust applications per acre of vineyard
			Vineyard	Orchard	Total			
Arkansas (1929)		Number	Acres	Acres	Acres	Number	Hours	Number
Power sprayers	hired	13	7.5	6.5	14.0	-	-	2.1
Hand pump sprayers	owned	10	7.1	4.6	11.7	9.5	67	2.9
Power sprayers	owned 2/							
Hours used per season per sprayer								
Less than 50		9	9.7	2.2	11.9	8.5	32	2.8
50 to 99		18	12.6	6.8	19.4	16.0	71	2.8
100 to 149		8	16.1	10.5	26.6	7.2	117	2.6
150 and more		12	12.0	22.8	34.8	10.5	246	3.1
Power sprayers	owned 3/	7	50.1	75.8	125.9	22.0	292	3.2
Michigan								
Power sprayers	hired	12	13.0	2.7	15.7	-	-	-
Power sprayers	owned 2/							
Hours used per season per sprayer								
Less than 50		13	21.2	4.5	25.7	13.0	33	1.8
50 to 99		14	22.8	3.6	26.4	13.5	67	2.2
100 and more		13	23.3	11.8	35.1	13.0	159	3.2
Power dusters	hired	5	31.8	.8	32.6	-	-	1.2
Power dusters	owned	15	37.5	5.2	42.7	14.5	42	2.6
Chautauqua-Erie								
Power sprayers	hired	13	17.0	2.2	19.2	-	-	1.3
Power sprayers	owned 2/							
Hours used per season per sprayer								
Less than 50		30	19.8	5.0	24.8	28.5	28	1.1
50 to 99		28	33.0	10.1	43.1	28.0	69	1.1
100 and more		15	32.9	27.6	60.5	14.0	208	1.6
Power dusters	hired	6	35.0	11.4	46.4	-	-	1.0
Power dusters	owned	9	32.2	6.7	38.9	9.0	40	1.7
Finger Lakes, N.Y.								
Power sprayers	owned 2/	11	30.8	11.7	42.5	11.0	67	1.0
Traction sprayers	owned 2/	12	23.0	2.1	25.1	12.0	39	.9

1/ Only that share of a jointly owned sprayer or duster belonging to a grower whose vineyard was included in this study was counted in computing the total number of machines.
2/ Not more than one sprayer per farm.
3/ More than one sprayer per farm.

Machine Cost of Using Power Sprayers

On an average, power sprayers were used the greatest number of hours per season, in Arkansas, or 176 hours, and the least number in Michigan, or 78 hours. (table 74.)

Growers inventoried their sprayers at the end of 1928 at an average of $264 in Pennsylvania and $210 in Michigan. The average cost of operating sprayers for the year amounted to about one third of the inventory value. Gas and oil expense was a small part of the cost, varying from an average of $5 per sprayer for Michigan to $14 for Arkansas. Depreciation was the largest cost item and varied from an average of $29 per machine for Michigan to $41 for Pennsylvania.

Table 74. - Machine cost of using power sprayers used in vineyards, by States, 1928 1/

Item		New York	Pennsylvania	Michigan	Arkansas (1929)
Sprayers, end of year	number	57	50	43	67
Season's use per sprayer					
Vineyard	hours	32	42	53	76
Other	do	84	45	25	100
Total	do	116	87	78	176
Inventory value of sprayer at end of year	dollars	222	264	210	211
Cost per season, per sprayer					
Depreciation 2/	do	32	41	29	31
Repairs	do	10	6	13	19
Gas	do	6	5	4	11
Oil	do	2	1	1	3
Interest	do	14	15	16	17
Other 2/	do	7	8	7	9
Total	do	71	76	70	90
Cost of sprayer operation per hour	do	0.61	0.87	0.90	0.51

1/ Number of sprayers at end of year: Number of different machines for which cost data were complete. Any sprayer or duster owned jointly with a farmer not included in this study was counted as one machine.
2/ See footnotes 2 and 3, Table 72.

On an average, depreciation costs decreased as the age of the sprayer increased. The depreciation during the first or second year the sprayer was used averagedabout $75 per season. About half as much, or $37, was the yearly depreciation of sprayers that had been used six seasons. In 1928, depreciation averaged only $18 for machines bought before 1922. (table 75.)

Table 75. - Number and value of power sprayers that were purchased new in the year indicated, sprayers for all areas combined, 1928

Year purchased 1/	New sprayers purchased	Initial cost per sprayer	Inventory value per sprayer in 1928		Depreciation in 1928
			Beginning of year	End of year	
	Number	Dollars	Dollars	Dollars	Dollars
Prior to 1922	21	372	170	152	18
1922	12	451	125	156	39
1923	24	504	292	255	37
1924	28	469	274	238	36
1925	20	463	259	212	47
1926	23	490	355	313	42
1927	9	576	451	376	75
1928	9	641	2/ 641	565	76

1/ The Arkansas data were for 1929 and the other data were for 1928, and the Arkansas sprayers purchased in 1929 were included with the sprayers purchased in the other areas in 1928, etc.
2/ Average cost of sprayers purchased during the year.

The average price paid for new sprayers bought before 1922 was $372. Prices paid for sprayers tended to increase from 1922 to 1928, the average for 1928 being $641. (table 75.) The sprayers bought in 1928 were generally of larger size than those bought prior to 1922.

Not taking into account the quality of spraying, the old sprayers were operated more economically than the new ones. The average cost per hour of use for the sprayers purchased new in 1927 and 1928 was $1.15 compared with $ .77 per hour for sprayers that were purchased new during 1924, 1925, and 1926. The older sprayers were operated more economically in 1928 because the depreciation, interest and repair costs amounted to only $68 per machine compared with $106 for the newer machines.

More was spent for repairs on the oldest machines than on the newest machines but depreication and interest were less on the oldest sprayers. On the average, the oldest machines were used more hours during the season than the newest machines were used, and the cost per hour for the oldest machines averaged but 62 cents, as compared with a cost of $1.15 per hour for the newest machines. (table 76.)

Arkansas grape growers more frequently bought used sprayers than did growers in the other States. Dealers probably traded with the apple growers, new sprayers for old ones, and sold the old sprayers to grape growers. On Arkansas farms where sprayers were used less than 100 hours during the season, only about one half of the sprayers had been purchased when new. (table 77.) The price paid for the used machines was about one third of the price paid for the new sprayers. The machine cost per hour of use to those who purchased used sprayers was about one half as much as the cost to those who had purchased new machines. Most of the growers who had more than 100 hours of work for a sprayer during the year purchased their machines when they were new.

Table 76. - Machine cost of using power sprayers that were purchased new by the 1928 owner, by age classes, all areas 1/

Item		Power sprayer purchased -		
		Prior to 1924	1924-1926	1927-1928
Sprayers	number	57	71	18
Season's use, 1928	hours	147	111	110
Initial cost	dollars	444	474	609
Inventory value at end of 1928 season	do	196	255	471
Cost during season				
Gas and oil	do	14	8	7
Repairs	do	23	9	7
Depreciation	do	30	41	75
Interest	do	15	18	24
Other	do	9	10	13
Total	do	91	86	126
Cost per hour of use	do	0.62	0.77	1.15

1/ Data for Arkansas were taken for a year later than data for the other areas, and the power sprayers purchased in Arkansas in 1924 were included in the age group, prior to 1924; the years 1925-1927 in the age group, 1924-1926; the years 1928-1929 in the age group, 1927-1928.

Table 77. - Machine cost of using power sprayers that were purchased as new and as used machines, Arkansas sprayers, 1929

Item		Sprayers used less than 100 hours during season		Sprayers used 100 hours or more during season	
		Purchased when new	Purchased as used machine	Purchased when new	Purchased as used machine
Sprayers	number	12	12	24	5
Season's use, 1929	hours	57	56	283	204
Initial cost	dollars	460	143	517	191
Inventory value at end of 1929 season	do	233	119	264	138
Cost during season					
Gas and oil	do	4	4	29	12
Repairs	do	5	13	31	25
Depreciation	do	37	7	50	2
Interest	do	20	9	22	11
Other	do	7	3	15	7
Total	do	73	36	147	57
Cost per hour of use	do	1.28	0.64	0.52	0.28

Size of sprayer was associated with the season's total spraying work. On an average, sprayers of 200 gallons capacity were used 187 hours during the season whereas sprayers of 50 to 100 gallons capacity were used only 69 hours. (table 78.) Although it usually took longer to spray an acre of grapes with the larger outfits than with the smaller ones, about twice as much spray was applied per acre per application with the larger outfits.

Table 78. - Size of power sprayers used in vineyards, and cost factors, by States, 1928

Approximate capacity of sprayer (gallons)	New York	Pennsylvania	Michigan	Arkansas (1929)	Total
POWER SPRAYERS					
	Number	Number	Number	Number	Number
50	5	0	0	1	6
100	18	5	22	8	53
150	18	18	18	15	69
200 and more	13	26	3	43	85
Total	1/ 54	2/ 49	43	67	213
USE OF SPRAYER DURING SEASON (VINEYARD AND ORCHARD WORK)					
	Hours	Hours	Hours	Hours	Hours
50 to 100	61	67	78	70	69
150	77	75	70	104	80
200 and more	263	100	130	220	187
Average	115	88	78	175	120
MACHINE COST OF USING SPRAYER FOR SEASON (VINEYARD AND ORCHARD WORK)					
	Dollars	Dollars	Dollars	Dollars	Dollars
50 to 100	46	43	75	29	54
150	61	67	60	49	60
200 and more	129	89	88	116	109
Average	71	76	70	90	78
SPRAY MATERIAL PER ACRE OF GRAPES (ONE APPLICATION)					
	Gallons	Gallons	Gallons	Gallons	Gallons
50 to 100	81	75	86	76	82
150	155	118	83	99	105
200 and more	265	115	129	184	164
Average	148	112	88	155	125
TOTAL SPRAYING COST PER ACRE OF GRAPES (ONE APPLICATION) 3/					
	Dollars	Dollars	Dollars	Dollars	Dollars
50 to 100	4.95	4.59	4.16	3.31	4.25
150	7.24	5.68	3.13	4.00	4.53
200 and more	7.72	5.22	4.98	5.56	5.57
Average	6.39	5.30	3.75	5.01	4.91

1/ Does not include 3 sprayers for which detailed information was incomplete.
2/ Does not include 1 sprayer for which detailed information was incomplete.
3/ Includes cost of materials, labor, power, use of sprayer, etc.

The cost per hour for the use of a sprayer was largely determined by the number of hours the sprayer was used during the season. About 3 sprayers out of 10 were used less than 50 hours during the season, averaging 30 hours. The cost per hour for these sprayers averaged $1.70. (table 79.) Twenty-seven percent of the sprayers were used 150 hours and more, averaging 279 hours per season, and the cost per hour for these sprayers was only 44 cents. Sprayers which were used 279 hours, did twice as much orchard as vineyard work. Many of the large sprayers would not have been owned on these farms except for the orchards.

Table 79. - Relation between hours that power sprayer was used during season and cost of use, data combined for all areas, 1928 1/

Item		Sprayer used -			
		Less than 50 hours	50 to 99 hours	100 to 149 hours	150 hours and more
Sprayers	number	64	70	23	60
Season's use per sprayer					
Vineyard	hours	25	44	59	89
Other	do	5	24	57	190
Total		30	68	116	279
Inventory value of sprayer at end of year	dollars	213	209	215	265
Cost per season, per sprayer					
Depreication	dollars	27	29	34	44
Repairs	do	4	7	14	26
Gas	do	2	4	6	17
Oil	do	-	1	1	5
Interest	do	13	14	16	19
Other	do	5	6	8	12
Total		51	61	79	123
Cost of sprayer per hour	do	1.70	0.90	0.68	0.44

1/ Arkansas, 1929.

Spraying and Dusting Crews

Three fourths of the vineyard spraying in Arkansas was done with a crew of 3 men, usually 2 men who followed the machine, each directing a nozzle at the end of a long hose, and a driver. The trailer system was also generally followed in Hudson Valley, where 78 percent of the spraying was done with a crew of 3 men or more. (table 80.) In Michigan over one half of the spraying of vineyards was done with one man to the outfit. Nozzels were fastened to a frame on the side and rear of the machine. In the remaining areas, 2 men were more commonly used with a sprayer than any other number.

Table 80. - Proportion of power spraying and dusting done with indicated number of men in crew, by areas, 1928

Area	Percentage of acreage covered by indicated number of men in crew: 1	2	3	4 or more	Crew not reported	Total	Acreage covered 1/
	Percent	Percent	Percent	Percent	Percent	Percent	Acres
Spraying:							
Arkansas (1929)	2.1	15.7	76.6	5.2	0.4	100.0	2998
Michigan	56.8	36.9	4.3	2.0	-	100.0	2968
North East, Pa.	21.1	67.6	9.0	2.3	-	100.0	1498
Girard, Pa.	4.5	86.1	4.3	-	5.1	100.0	603
Chautauqua Co.,N.Y.	37.9	45.9	16.2	-	-	100.0	582
Finger Lakes, N.Y.	9.0	69.2	21.8	-	-	100.0	761
Hudson Valley, N.Y.	-	21.5	60.2	18.3	-	100.0	252
Niagara Co., N.Y.	-	100.0	-	-	-	100.0	21
All areas	24.6	41.0	31.0	3.0	0.4	100.0	9683
Dusting:							
Michigan	88.3	11.7	-	-	-	100.0	1917
Chautauqua-Erie	55.4	26.8	17.8	-	-	100.0	709

1/ Example: 25 acres sprayed or dusted 2 times was counted as 50 acres; sprayed or dusted 3 times, as 75 acres, etc.

In each of the areas, except Girard, most of the spraying of vineyards was done with 2 horses. In Girard, 71 percent of the spraying was done with tractors. (table 81.) In the Finger Lakes area about 30 percent of the spraying was done with 1 horse. Dusting of vineyards was usually done with 1 man and 2 horses.

Table 81. - Relative importance of different kinds and units of power used in hauling power sprayers and power dusters in vineyards, by areas, 1928

Kind and area	Percentage of vineyard acreage covered by indicated number of horses: 1	2	3 or more	Percentage of vineyard acreage covered by - Tractor	Power not reported	Total	Acreage covered 1/
	Percent	Percent	Percent	Percent	Percent	Percent	Acres
Sprayer:							
Arkansas (1929)	1.1	92.7	1.3	4.5	0.4	100.0	2998
Michigan	1.3	94.2	0.9	3.6		100.0	2968
North East, Pa.		76.4		23.6		100.0	1498
Girard, Pa.		24.2		70.7	5.1	100.0	603
Chautauqua Co.,N.Y.		88.1		11.9		100.0	582
Finger Lakes,N.Y.	29.8	50.7		19.5		100.0	761
Hudson Valley,N.Y.	2.8	80.2		5.9	2/11.1	100.0	252
Niagara Co., N.Y.		100.0				100.0	21
All areas	3.2	82.5	0.7	12.9	0.7	100.0	9683
Duster:							
Michigan	2.6	93.5		3.9		100.0	1917
Chautauqua-Erie	2.1	84.8		13.1		100.0	709

1/ Example: 25 acres sprayed or dusted 2 times was counted as 50 acres; sprayed or dusted 3 times, as 75 acres, etc.

2/ Auto and truck.

Increasing the number of men per crew usually increased the cost of spraying. Thus, increasing the number of men from 1 to 2, increased the cost of spraying per acre 74 cents in Michigan and 80 cents in the Chautauqua-Erie belt. (table 82.) This comparison is of cost alone and does not consider the effectiveness with which the spray was applied. More spray was applied per acre and the foliage was probably more effectively covered with the larger outfits.

Table 82. - Cost per acre of vineyard for applying one spray or dust with indicated crew, by areas, 1928

Kind, area and crew	Vineyards	Amount applied per acre	Time to cover one acre	Cost per acre: Man labor	Motive power	Machine	Total 1/
	Number	Gallons	Hours	Dollars	Dollars	Dollars	Dollars
Power sprayer							
Arkansas (1929)							
2 men-3 horses	8	101	1.5	0.74	0.43	1.02	2.19
3 men-2 horses	49	166	2.0	1.36	.56	1.10	3.02
Michigan							
1 man-2 horses	30	81	0.9	.43	.39	1.11	1.93
2 men-2 horses	19	99	1.2	1.04	.57	1.06	2.67
3 to 5 men - 2 to 3 horses	5	125	1.4	1.97	.48	1.28	3.73
Chautauqua-Erie							
1 man-2 horses	22	113	1.4	.80	.49	1.58	2.87
2 men-2 horses	31	149	1.4	1.26	.79	1.62	3.67
3 men-2 horses	10	97	1.4	1.90	.61	1.10	3.61
1 to 2 men-tractor	18	117	0.8	.85	.63	.97	2.45
Hudson Valley							
3 men-2 horses	7	142	2.0	2.57	1.04	1.17	4.78
Finger Lakes							
1 to 3 men-1 to 2 horses	11	70	1.1	1.09	.42	1.19	2.70
Traction sprayer							
Finger Lakes							
1 to 2 men- 1 to 2 horses	14	42	1.6	1.25	.48	.33	2.06
Power duster							
Michigan		(Pounds)					
1 man-2 horses	17	16	0.4	.17	.13	.51	.81
Chautauqua-Erie							
1 man-2 horses	5	21	0.5	.21	.28	.92	1.41
2 men-2 horses	5	27	0.3	.23	.18	.71	1.12

1/ Does not include cost of material.

In the Chautauqua-Erie area 18 vineyards were sprayed with a tractor-drawn outfit. It required less time per acre, on the average, to spray these vineyards with a tractor-drawn outfit than it did other vineyards in the Chautauqua-Erie area where horses were used to haul the sprayer. The total cost of spraying an acre of vineyard once averaged less for the tractor-drawn than for the horse-drawn sprayers.

The average spraying and dusting costs per acre, by areas, for all vineyards included in the study, varied from an average of $13.72 per acre for vineyards studied in Arkansas to 44 cents per acre for vineyards studied in Niagara County, N.Y. (table 83.) The lower area costs per acre are due in large part to the fact that much of the acreage was not sprayed or dusted. The averages were obtained by dividing the total cost of spraying or dusting the vineyards studied by the total acreage of vineyards. The spraying and dusting costs for Arkansas in 1929 amounted to 22.8 percent of the total cost of growing grapes. The cost of growing grapes did not include the cost of harvesting and marketing. In Michigan the spraying and dusting costs amounted to 11.2 percent and in Girard to 9.7 percent of the total growing costs.

On an average, for the vineyards studied in Chautauqua County, N.Y., and in the Finger Lakes area the spraying and dusting costs were less than $2.00 per acre and amounted to less than 3 percent of the total cost of growing grapes.

On the average, about one third of the cost of spraying and dusting was for labor and for horse and tractor work. The cost of the dust and spray materials applied to vineyards amounted to a little more than one third, and the use of the sprayer, duster and other tools, to somewhat less than one third of the total dusting and spraying costs. Another item of cost was interest on the spraying and dusting costs which varied from an average of 1 cent an acre for Niagara County to 27 cents for Arkansas.

Table 83. - Average cost per acre for spraying and dusting vineyards, by areas, 1928 1/

Area	Spraying and dusting costs per acre							Percentage of total growing cost
	Labor	Horse and tractor work	Sprayer and duster	Other tools	Materials	Interest	Total	
	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Dolls.	Percent
Arkansas (1929)	3.98	1.62	2.89	.38	4.58	.27	13.72	22.8
Girard, Pa.	1.28	1.01	2.56	.35	3.09	.26	8.55	9.7
Hudson Valley, N.Y.	2.82	.69	.91	.30	2.08	.20	7.00	5.3
Michigan	1.06	.65	1.71	.26	2.71	.22	6.61	11.2
North East, Pa.	.90	.52	1.05	.23	2.13	.16	4.99	6.2
Chautauqua Co.,N.Y.	.41	.22	.52	.08	.63	.05	1.91	2.6
Finger Lakes, N.Y.	.53	.19	.37	.07	.32	.04	1.52	2.2
Niagara Co., N.Y.	.14	.03	.10	.02	.14	.01	.44	0.6
All vineyards	1.14	.55	1.19	.19	1.87	.14	5.08	7.0

1/ Area averages obtained by dividing total spraying and dusting costs for vineyards studied in an area by the total acreage of the vineyards.

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